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Gerard Klein

symbolic, nonabstract properties of the stimuli e.g. size, color, shape, texture, sequence, etc. are relegated to perception." (p.544). Hammill (1972) suggests that in psychometrics most geometric form-copying tests adhere to the last definition of visual-perceptual processes and can best be summarized as "those brain operations which involve interpreting and organizing the physical elements of the stimulus rather than the symbolic aspects of the stimulus and are usually referred to as visual discrimination and spatial relationships" (p.553). This definition is reflected in statements often found in works dealing with geometric form-copying tests. For example, Bender (1938), in her book introducing the Bender-Gestalt states, "The motor behaviour of the small child... adapts itself to resemble the stimulus perceived in the optic field" (p.9). Koppitz (1964) in her monograph describing the widely used Developmental Scoring System for the Bender Test defines visual-motor perception in part as "The ability to perceive and to copy lines and shapes correctly in regard to direction and form" (p.9). Thus, in using geometric form-copying tests, clinicians apparently assume that the ability to reproduce figures is dependent on accurate perception of the stimulus feature of designs (Newcomer and Hammill, 1973).

THE DIAGNOSTIC USE OF GEOMETRIC FORM-COPYING TESTS: AN INVESTIGATION OF NORMAL KINDERGARTEN AND LEARNING DISABLED CHILDREN'S ERROR PRODUCTION.

by

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ABSTRACT

Geometric form-copying tests are widely used in the diagnosis of children with perceptual difficulties, based on the assumption that incorrect reproductions result from perceptual deficits. The research presented in this thesis, undertaken to investigate children's copying errors, not only seriously questions this assumption but also suggests an alternative explanation for the production of these errors.

Using designs from the Bender Visual-Motor Gestalt Test, Benton Revised Visual Retention Test, and McCarthy Scale of Children's Ability, it was found that both normal kindergarten and learning disabled children did not consistently produce the same categories of error , nor did they incorrectly reproduce designs in the same way across repeated testings. Moreover, kindergarten children did not regard their own incorrect drawings as equivalents of the stimulus figure upon subsequent comparison. These results suggest that errors were not tied to intrinsic properties of designs; consequently, it was unlikely that these errors stemmed from children's inherent perceptual deficits.

Alternatively, the experimental data suggest that copying errors may result from children's momentary lapses in attention, possibly due to their distractibility. Focussing the attention of both kindergarten and learning disabled children on the designs through reinforcement significantly reduced the number of errors, whereas distracting the children's attention by utilizing response sheets containing extraneous cues markedly increased the number of errors. It was also possible to focus attention of the kindergarten children by requesting that they verbally describe each design prior to copying it. This again significantly reduced error reproduction regardless of the accuracy of such descriptions. Furthermore, kindergarten children with high teacher ratings of distractibility tended to produce the greatest number of errors.

The traditional use of copying and similar tests to diagnose and prescribe remediation in perceptual areas is consequently called into question. Instead, it is suggested that such tests may be more efficacious in the diagnosis of attention problems.

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CHAPTER I

INTRODUCTION

Many educational and clinical psychologists assume that perceptual-motor deficits underlie children's academic problems. Tests of perceptual-motor competence are widely used to assess and diagnose children presenting school-related difficulties. Among the most widely used of these instruments are the Bender Visual-Motor Gestalt Test (Bender, 1938) and the Benton Revised Visual Retention Test (Benton, 1974). One survey for example, found that clinical psychologists administer the Bender-Gestalt more frequently than other major intellectual and psychodiagnostic tests (Lubin, Wallis and Paine, 1971), while another survey of assessment practices in various clinical and education settings found prevalent use of the Benton Test (Tarnopol, 1968).

The Bender-Gestalt and the Benton require children to copy various geometric forms and are used for a number of reasons. Sometimes they are selected as early screening devices; that is, to identify young children at risk for school failure (Keogh, 1969; Keogh and Smith, 1967; Kerr 1972; McCarthy, 1975). They are also administered to identify students with learning disabilities (Feuerstein, Ward and LeBaron, 1979; Golden and Anderson, 1979; Myers and Hammill, 1969; Tarnopol, 1969).

Such uses may be justified. The Bender-Gestalt has good predictive validity, demonstrated in numerous studies which have found that test performance of kindergarten and grade one children is significantly related to academic performance (Baker and Thurber, 1976; Dibner and Korn, 1969; Henderson, Butler and Jaffeney, 1969; Keogh and Smith, 1967; Koppitz, 1964; Koppitz, Mardis and Stephens, 1961; Mlodonsky, 1972). It is also clinically valid insofar as findings consistently demonstrate that learning-disabled children perform more poorly on the Bender-Gestalt than non-disabled children of equivalent ages (Ackerman, Peters and Dykman, 1971; Feuerstein, Ward and LeBaron, 1979; Klatskin, McNamara, Shaffer and Pincus, 1972; Larsen, Rogers and Sowell, 1976; Owen, Adams, Forrest, Stolz and Fisher, 1971).

The Perceptual-Deficit Account. Most users of geometric form-copying tests go beyond using these tests simply to identify children at risk for school failure and/or with learning disabilities. Based on the assumption that children's difficulties in reproducing designs from these tests stem from visual perceptual deficits (Bender, 1938; Dehirsch, Jansky and Langford, 1966; Fidel and Ray, 1972; Koppitz, 1964), they go on to diagnose the problem as being one of perceptual dysfunction (Anastasi, 1976; Bauman and St. John, 1971; Coy, 1974; Weiss and Peterson, 1974). This diagnosis usually results in prescription of remediation emphasizing visual-perceptual activities (Zach and Kaufman, 1972).

The assumption implicit in this diagnostic-prescriptive practice raises some questions which need to be resolved; first, what exactly is meant by "visual-perceptual processes?"; second, what evidence is there that these tests in fact measure visual perceptual abilities?; and finally, are there other factors which might be better predictors of children's test performance.

The investigation of visual-perceptual processes has been complicated by the variety of definitions of the term "perception" which are currently used by professionals in the field. Hammill (1972) located 33 definitions of perception in the current literature. He summarized them as following: to some theorists, a definite minority, the entire receptive process is called 'perception'. To others a distinction is made between sensation (i.e. the passive reaction of the receptor cell, a reaction not involving memory) and perception (i.e. the remainder of the receptive process). Others write only of sensation and cognition, where 'perception' is subsumed under cognition. Still others distinguish among 'sensation', 'perception', and 'cognition.' In this case, the processes which involve thinking, meaningful language, problem solving, etc. are assigned to 'cognition' while those dealing with nonsymbolic, nonabstract properties of the stimuli e.g. size, color, shape, texture, sequence, etc. are relegated to perception." (p.544). Hammill (1972) suggests that in psychometrics most geometric form-copying tests adhere to the last definition of visual-perceptual processes and can best be summarized as "those brain operations which involve interpreting and organizing the physical elements of the stimulus rather than the symbolic aspects of the stimulus and are usually referred to as visual discrimination and spatial relationships" (p.553). This definition is reflected in statements often found in works dealing with geometric form-copying tests. For example, Bender (1938), in her book introducing the Bender-Gestalt states, "The motor behaviour of the small child... adapts itself to resemble the stimulus perceived in the optic field" (p.9). Koppitz (1964) in her monograph describing the widely used Developmental Scoring System for the Bender Test defines visual-motor perception in part as "The ability to perceive and to copy lines and shapes correctly in regard to direction and form" (p.9). Thus, in using geometric form-copying tests, clinicians apparently assume that the ability to reproduce figures is dependent on accurate perception of the stimulus feature of designs (Newcomer and Hammill, 1973).

It is also widely held that difficulties in copying designs not only result from distorted perceptions but that these misperceptions stem from inherent inabilities. In other words, as Salvia and Ysseldyke (1978) point out in their critical review of the Bender-Gestalt, poor test performance is usually not viewed as due to a failure in applying efficiently capabilities which may be present in the child but rather inherent deficits in perceptual abilities. Koppitz (1975) clearly advocates this position when she says, "Increase in motivation, instructions in matching, tracing, copying and labeling the Bender Test designs and perceptually training appear to have little effect on the test performance of groups of children ....the Bender performance of young children reflects primarily their level of maturation in perceptual-motor integration" (p.27).

Few empirical investigations have been directed towards validating the perceptual-deficit interpretation of children's errors. Salvia and Ysseldyke (1978) indicate that the perceptual-deficit account is based on unsubstantiated claims by the tests' author rather than on actual research findings. Test reviewers also comment upon the paucity of research which directly validates the prevailing explanation (Blakemore, 1969; Chisson, 1972; Hanawalt, 1965; Mann, 1959; Payne, 1972). Moreover, recent investigations (Brittain, 1976; Naeli and Harris, 1976; Simner, 1979) of preschool children's difficulties in copying simple shapes and grade school children's production of reversal and other letter errors suggest an alternative interpretation. These studies suggest that copying errors may result from children's momentary lapses in attention possibly due to their distractibility.

The Attention Account. Young children often have difficulty selectively attending to important information when completing various tasks because they are distracted by and respond to irrelevant stimuli (Day, 1975; Hagen and Hale, 1973; Wright and Vliestra, 1975). Recent studies have also suggested that copying problems exhibited by preschoolers may result from inadequate attention to task items because of distraction by irrelevant cues. (Brittain, 1976; Naeli and Harris, 1976).

One manifestation of children's distractibility is that incorrect reproductions of geometric shapes can be manipulated by altering the contours of response sheets. For example, children have greater difficulty drawing triangles and diamonds on rectangular response sheets in comparison to drawing triangles on triangular response sheets, or diamonds on diamond-shaped paper (Brittain, 1976; Naeli and Harris, 1976). Children also successfuly draw squares on rectangular paper but have difficulty executing the same task on triangular sheets (Naeli and Harris, 1976).

Similarly, preschoolers' problems with obliques are more apparent when presented with a rectangular, as opposed to a circular frame, and when asked to draw obliques on rectangular instead of circular paper (Appelle, 1972; Arnhein, 1969; Berman, Cunningham and Harkulich, 1974; Olson, 1970). These studies seem to indicate the preschool childrens' distraction by irrelevant cues may well interfere with their ability to copy simple shapes.

Simner's (1979) recent analysis of grade school children's production of mirror-image errors that such errors might result from distractibility and failure to attend to relevent task details. The research demonstrates that inadequate attention can lead to poorly formed memory images, this producing letter reversal and other errors. Simner identified this pattern by analyzing the strokes forming individual letters, and discovered that errors were made primarily at the terminal stages of construction. Errors occurred most frequently in work produced by kindergarten and grade one children who also received high teacher ratings of distractibility. Furthermore, focussing children's attention on the letters by having the children name the letters before and during printing resulted in fewer errors of all types.

The previously outlined investigation of preschoolers' difficulties in copying simple shapes and Simner's analysis of letter errors both suggest that incorrect reproductions result from selective attention problems. Given the similarity between copying tasks and the demands of geometric form-copying tests, an attentional interpretation might be a more reasonable explanation of children's performance than the perceptual-deficit account. An examination of the clinical literature presents further research support for the attention-deficit interpretation.

With reference to the attention-distraction element, one such study found that mentally retarded and non-retarded children generate more errors when they copy the nine Bender-Gestalt figures on one response sheet as opposed to copying each design on a separate sheet (Allen, 1968; Allen and Frank, 1962). This finding could be due to the fact that, under the first condition, the children have to deal with distracting effects of figures already drawn, whereas under the second condition these distracting stimuli are absent. In another study, emotionally disturbed, learning-disabled, mentally-retarded and non-handicapped children all appeared to have more difficulty drawing Bender figures on response sheets containing the moderately dense criss-crossing lines of the Background Interference Procedure (Canter, 1963) in comparison to requirements to reproduce the Bender figures using the standard blank response sheets (Adams, 1970; Adams and Canter, 1969; Adams, Hayden and Canter, 1974; Adams, Kenny and Canter, 1973). In a third study examining attention-distraction factors, Sabatino and Ysseldyke (1972) found that non-readers generate more mistakes when administered Bender-Gestalt designs on cards containing extraneous background cues such as diagonals and dots in comparison to the standard procedure presenting the same designs on white backgrounds. The three studies described above suggest the possibility that Bender-Gestalt errors can result from children's distraction by and response to extraneous cues which interfere with the ability to attend to relevant task detail.

Conclusions. The sum of evidence provided by these studies leads to an explanation of copying errors which provides an alternative to the prevailing perceptual-motor account. In light of such evidence, it may be inappropriate to diagnose poor performance on copying tests as indicative of perceptual deficits, when it may be more efficacious to diagnose difficulties in copying designs as stemming from attention lapses.

The objective of this thesis, and the research it is predicated upon, is to examine the viability of the perceptual-deficit and attentional explanations of children's poor performance on geometric form-copying tests. To summarize the two explanations: the perceptual-deficit account states that incorrect reproductions stem from children's distorted perception of the stimulus features of designs. Errors are also thought to result from inherent inabilities rather than a failure to apply those capabilities which may be present. According to the attention account, errors are due to children's momentary lapses in attention possibly due to their distractibility.

Four studies were undertaken to test specific predictions derived from the two accounts. The studies utilized designs from three widely used tests (Sundberg, 1961, Tarnopol, 1969) whose figures are representative of designs found in all other geometric form-copying tests.

The selected tests included the Bender Visual-Motor Gestalt Test (Bender, 1938), the Benton Revised Visual Retention Test (Benton, 1974) and the drawing test from McCarthy Scale of Children's Ability (McCarthy, 1972).

The first two studies investigated the perceptual-deficit explanation for children's copying task problems, while the third examined the attention-account. The first study (Chapter II) investigated whether kindergarten children consistently produce the same errors across repeated testings. If those supporting the perceptual-deficit account are correct, children's errors are a result of the way they misperceive designs; hence, children should generate the same errors across repeated testings. The second study (Chapter III) questioned whether kindergarten children regard their own incorrect reproductions as equivalents of the original designs. If an error reflects misperceptions of designs, the children should consider the original and the incorrect copy to be the same.

In the third study (Chapter IV), it was hypothesized that if errors result from attention lapses, then one should be able to decrease their frequency by focussing attention of the children on the general properties of designs. Conversely, distracting children's attention from the figures should result in a significant increase in the total number of errors. According to the perceptual-deficit account such manipulations should have little effect on their performance (Koppitz, 1975).

The fourth study, (Chapter V) replicated parts of the first and third experiments but utilized a clinical group of learning-disabled children. The learning difficulties experienced by these children are frequently attributed to perceptual deficits often reflecting neuorological dysfunctions (Cruickshank, 1972; Koppitz, 1971). Hence it was important to evaluate the extent to which performance of this population was due to perceptual difficulties or attentional factors.

CHAPTER II

EXPERIMENT 1

The purpose of this study was to test one of the predictions derived from the perceptual-motor account and that is, children should generate the same number of errors as well as the same types of errors across repeated presentations. Since one would argue from this account that children's errors result from distorted perception of the stimulus features of the designs, it would be reasonable to assume that children should display this consistency in performance.

Experiment 1 tested this prediction with kindergarten children by administering the Bender-Gestalt, the Benton Test and the McCarthy Scale on two separate occasions. The standard scoring systems of these tests evaluate the ways in which incorrectly copied designs are inaccurate, and score on the basis of the presence or absence of specific categories of error. For example, performance on the Bender-Gestalt is frequently scored using Koppitz's (1964) Developmental Scoring System in which the child's drawings of the nine Bender-Gestalt figures are marked for the presence of thirty criteria, each of which is considered to be a separate category of error.

The ten Benton Test protocols are scored for the presence of sixty-four types of error, while the nine McCarthy Scale protocols are awarded points for the absence of such error types.

Such systems implicitly assume that categories of error reflect deficits in perceptual abilities. Koppitz (1964) attempted to validate the Developmental Scoring System by comparing performance of grades one to four under-achievers to high achievers using the Bender. Based on the assumption that the former group has deficits in visual-motor perception, Koppitz argues that any category of error which differentiates high and low achievers automatically reflects deficits in the visual perceptual processes. She therefore selected only those types of error which occur significantly more often among under-achievers and thus established the thirty scoring criteria of the Developmental Scoring System.

Benton (1974) implies that Benton Test categories of error reflect perceptual deficits since they include every type of error reported in the literature on copying performance of brain-damaged individuals. Kaufman and Kaufman (1977) similarly infer that each of the error categories of the McCarthy Scale are manifestations of perceptual deficits. They argue that the types of errors found in the McCarthy Scale and Developmental Scoring System are closely related. In general, the individual categories of error derived from the standard scoring systems of the three tests are regarded as indicating deficiencies in perceptual functioning. Consequently, it was important to analyze the data from Experiment 1 not only for the total number of errors each child produced in repeated testings, but also more specifically according to types of errors, in order to test the inferences of the perceptual-deficit account.

Although the standard scoring systems emphasize evaluation of specific categories of error, Benton (1974) has suggested that there is merit in using a more gross measure of performance, that is, the number of incorrectly reproduced figures. Within this context and defining an incorrect copy as any figure scored as receiving a distinct category of error, it is possible to test another prediction inferred from the perceptual-deficit account. Children should consistently produce the same number of incorrect copies as well as incorrectly reproduce a figure in the same way across testing sessions. Experiment 1 tested this and the other prediction stated above.

Method

Subjects. The population consisted of 72 non-repeating kindergarten children (forty girls and thirty-two boys). Only one child was receiving remediation, (speech therapy). Subjects' age at the start of the study ranged from 63 to 75 months, with a mean of 69.3 months and a standard deviation of 3.5 months. The subjects, most of whom lived in their school neighbourhoods, attended three public schools located in middle and lower middle class communities. Written parental permission was obtained prior to testing all children.

Procedure. Each subject was individually tested using designs from the Bender-Gestalt, the Benton Test and the McCarthy Scale on two separate occasions, with a time lapse of two weeks between administrations. Testing took place during school hours in the child's own school, but in a room separate from the kindergarten. The testing room contained a table and chair where the child performed the tasks.

The child was introduced to the task with the following instruction: "I am going to show you some drawings. I want you to copy exactly what you see on a sheet of paper that I will give you. When you are finished copying a drawing, turn the paper over and place it in the brown box next to you." The box (30.4 x 15.2 x 10.1 cm) was placed to the right side at right-handed children and to the left of left-handed children.

The designs were administered one at a time using one of two random sequences, A or B, presented in Figure 1. The same twenty-eight geometric shapes were utilized in each of the two sequences but were presented in different order. Although the designs were selected from the Bender (nine drawings), the Benton (ten drawings) and the McCarthy (nine drawings), they were not presented to the children in discrete sections according to test derivation. Instead they were randomly mixed at the outset of the experiment, and then divided into two equivalent sequences. Half of the children received sequence A during the first session and B during the second, while the other half of the group was presented with the reverse order, first B and then A.

The geometric forms, printed in black, were individually presented on white cards (20.3 x 13 cm) contained in a wire notebook (Wire-In-Dex No. 08-248, National Blank Book Company, Holyoke, Mass.) placed on its unbound ends at a forty-five degree angle approximately 15 cm from where the child was seated. This

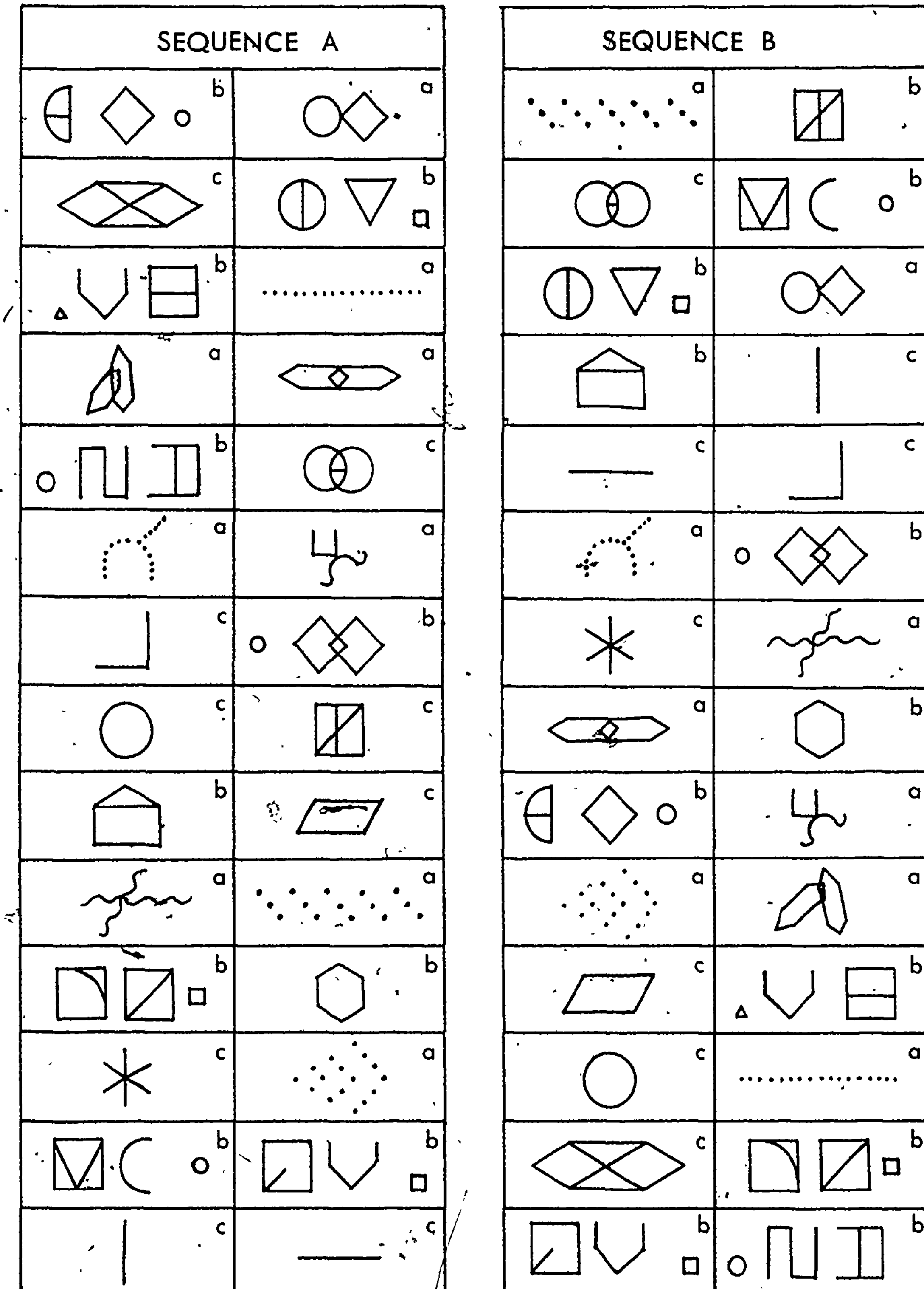


Figure 1. The two random sequences A and B. Note that Bender Test designs are designated by the letter a, Benton Test by letter b and McCarthy Scale by the letter c.

positioning allowed the subject a close and unrestricted view of the designs. With each figure, the subject was given a separate white sheet of paper to copy the design, and used a black lead Number 2 pencil. The response sheets were the same size as the stimulus cards, and the larger dimensions of both cards and response sheets were positioned horizontally to eliminate extraneous distraction.

Scoring. The nine Bender Test drawings were scored using Koppitz's (1975) Developmental Scoring System of thirty possible types of errors which fall into four general categories: rotation, integration, perserveration and distortion. In scoring the protocols, the presence of an error category is scored as one and its absence as zero; thus from the nine drawings of Bender test, total scores can range from zero (no error) to thirty (every possible error). The higher the score, the poorer the performance; the lower the score, the better the performance. Appendix I presents examples of this scoring system.

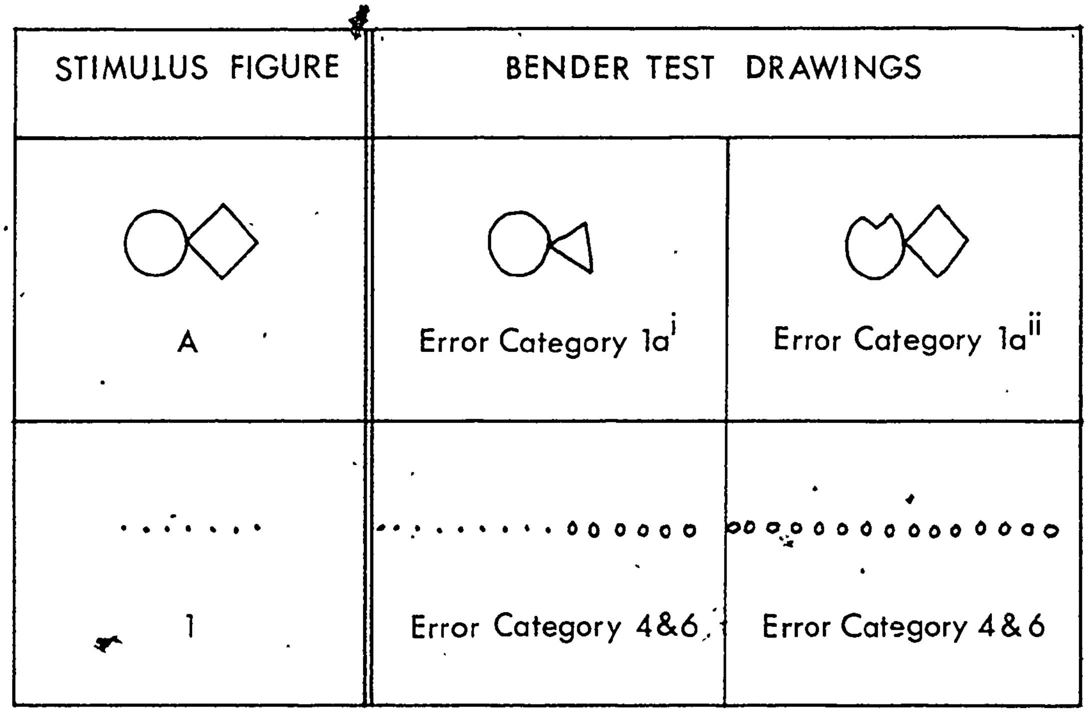
The Benton protocols were scored using the system in the Revised Visual Retention Manual (Benton, 1974), with sixty-four types of errors divided into six general categories: omissions, distortions, perserverations, rotations, misplacements and size errors. As with the Bender Test, the presence of an error category is scored as one, and its absence as zero; hence, for the 10 drawings of Benton designs, total scores can range from zero to sixty-four. High scores indicate poor performance, while low scores show good performance. Examples of the Benton scoring systems may be found in Appendix II.

Protocols of the McCarthy Scale were scored utilizing the McCarthy Scale Manual's (1972) system, depicted in Appendix III. Scored for minimal and additional criteria, each reproduction receives points according to how closely it resembles the stimulus figure. For the nine reproductions of the McCarthy figures, total scores can range from zero to eighteen, with the higher score indicative of better performance.

As pointed out earlier in the chapter, another procedure is to score for the total number of incorrect copies. This method of scoring protocols is a more global measure since any one incorrect drawing may include any number of distinct error categories. The prediction derived from the perceptual-deficit account is that children should generate the same type of incorrect copy across repeated testings. The following procedure was used to judge whether a given figure was incorrectly drawn in the same or different way across testing sessions.

A given Bender figure was judged incorrectly in the same way on two testings if it received exactly the same Koppitz error category or categories on both occasions (see figure 2). For example, stimulus Figure A was judged as incorrectly drawn in the same way if it received Koppitz error category la (distortion) on the first and also second administration. On the other hand, a given Bender figure was judged incorrectly drawn in different ways if one of the incorrect drawings received a Koppitz error category not found in the other copy (see figure 3). For example, stimulus figure A was judged incorrectly drawn in a different way if it received Koppitz error category 3 (integration) during one session but category lb (distortion) on the other. A further example of this type of judgement is stimulus figure 1 receiving Koppitz error category 5 (rotation) during one session but was correctly drawn on the other.

The same Criteria used to judge Bender incorrect copies were applied to judgements of Benton drawing errors, with the obvious substitution of Benton error categories. Figure 4 presents examples of drawings judged as incorrectly drawn in the same way during the two presentations, while figure 5 illustrates examples of incorrect copies judged as incorrectly drawn in different ways during the two testing sessions.



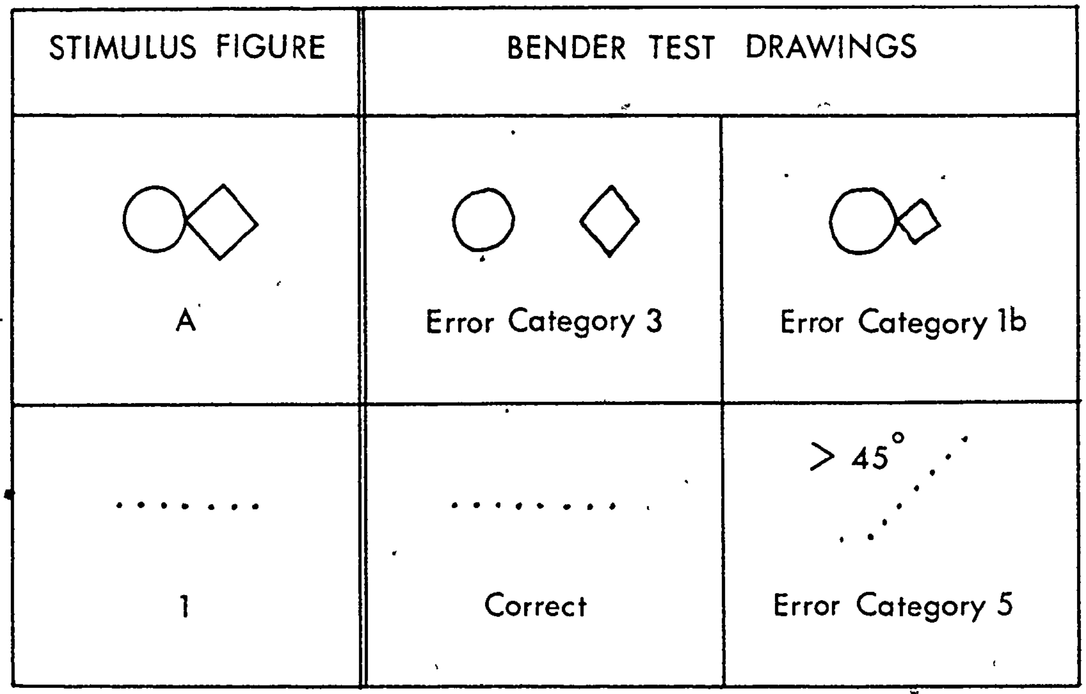
Error Category 1a^{i} distortion, diamond missing angle

Error Category 1a^{ii} distortion, circle has points or angles

Error Category 4 distortion, more than 5 dots converted into circles

Error Category 6 perserveration, more than 15 dots

Figure 2. Examples of Bender Test drawings judged as generating the <u>same</u> incorrect copies of a given stimulus figure.

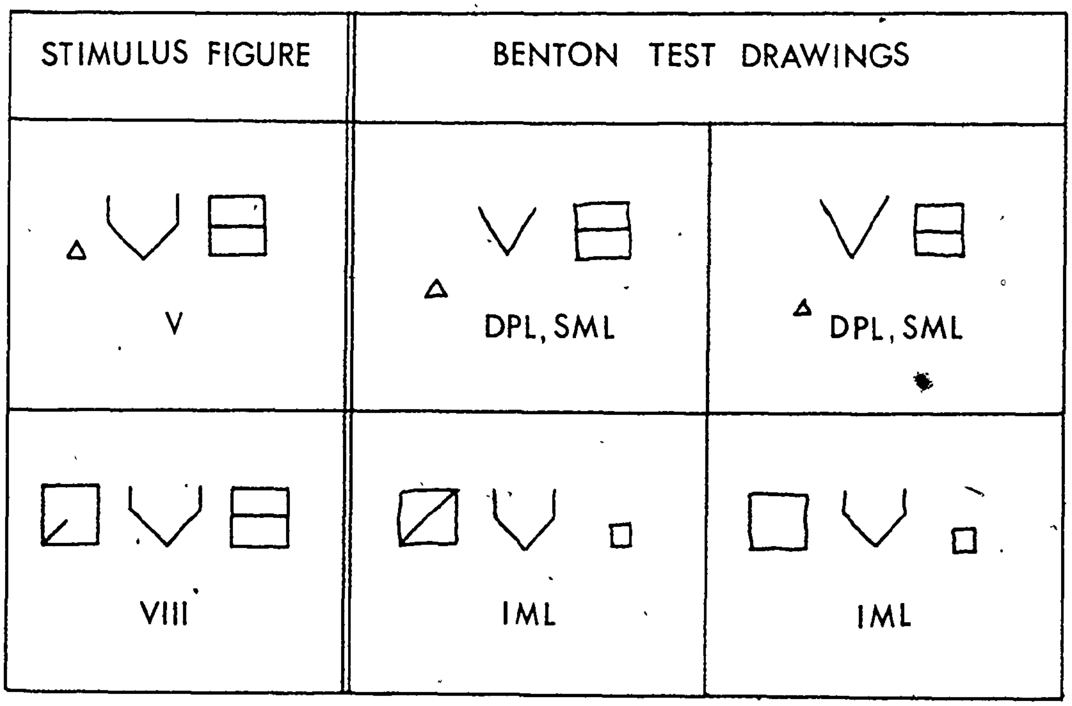


Error Category 1b distortion, circle twice as large as diamond

Error Category 3 integration, lack of overlap

Error Category 5 rotation, figure rotated more than 45°.

Figure 3. Examples of Bender test drawings judged as generating <u>different</u> incorrect copies of a given stimulus figure across testings.

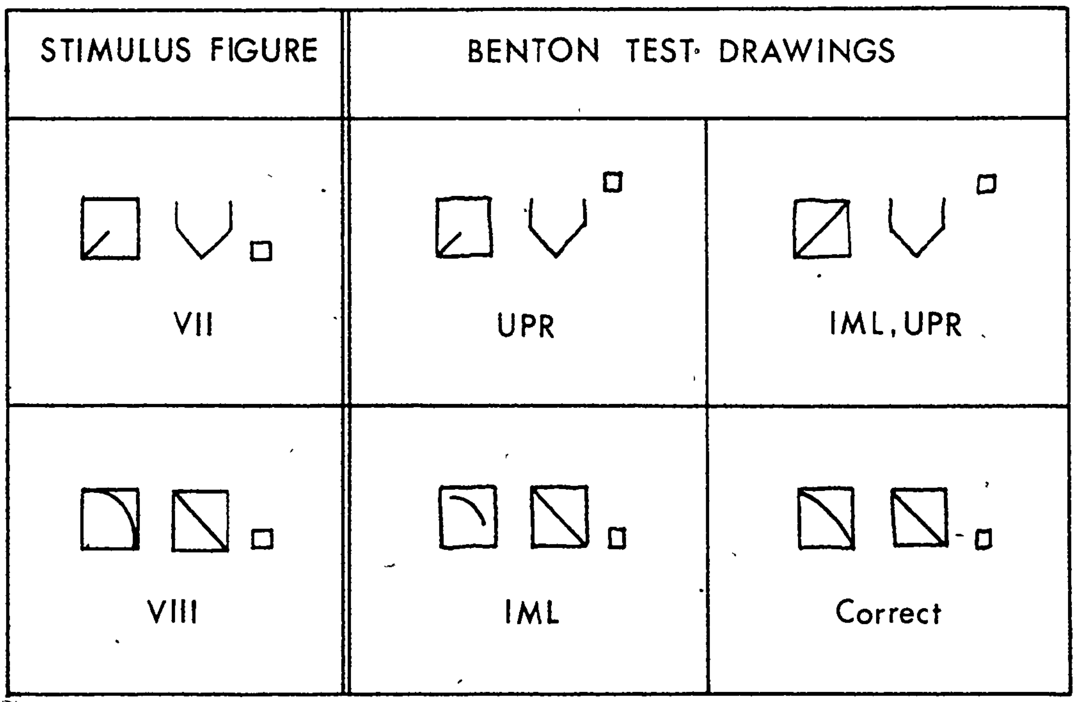


DPL. misplacement, peripheral figure too low

SML. distortion, left major figure incorrect

IML. distortion, incorrect reproduction of detail in left major figure.

Figure 4. Examples of Benton Test drawings judged as generating the <u>same</u> incorrect copies of a given stimulus figure across testings.



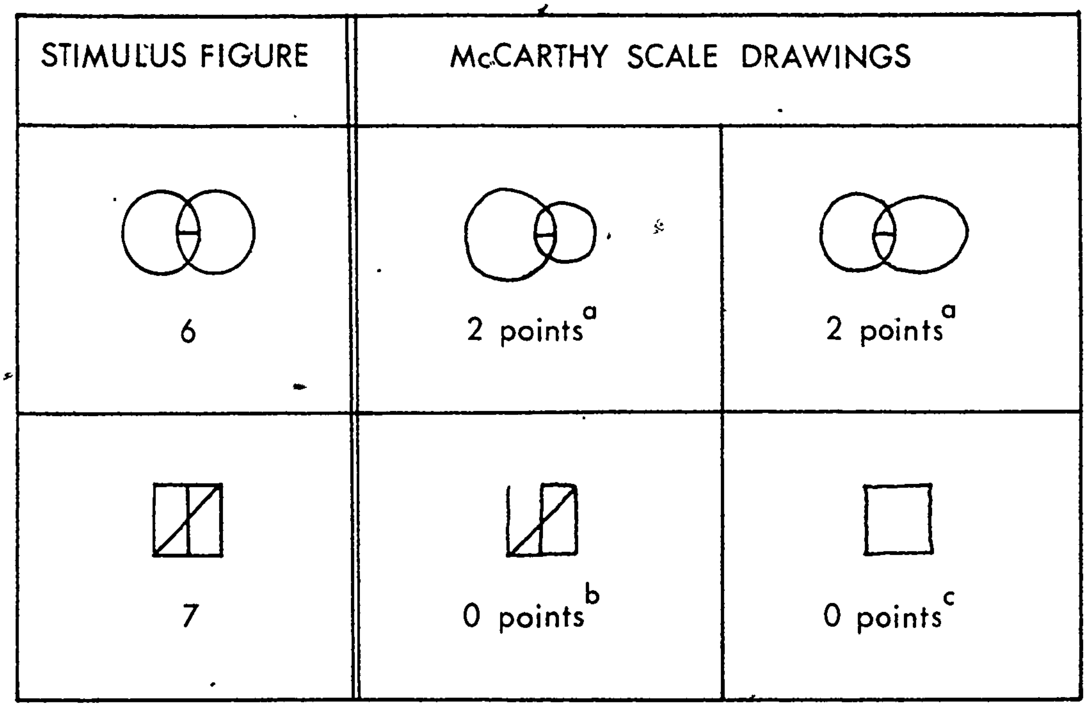
UPR. misplacement, peripheral figure too low.

IML. distortion, incorrect reproduction of detail in left figure.

Figure 5. Examples of Benton Test drawings judged as generating <u>different</u> incorrect copies of a given stimulus figure across testings.

As previously discussed, the McCarthy Scale scoring system varies from that of the Bender and Benton Tests in that protocols are awarded points for meeting specific criteria up to a maximum number of points, depending on the individual stimulus design. A drawing which does not receive the maximum score is therefore considered incorrectly drawn. This means that for the McCarthy scale, drawings of a given figure were judged as incorrectly drawn in the same way only if the drawings received exactly the same number of points across testings. Examples of this type of judgement are illustrated in Figure 6. If the two drawings of a given design received a different number of points each time, as depicted in Figure 7, the two copies were considered different. It should be noted that for the McCarthy items, although a given design appears to be differently drawn on both occasions, it may still be judged as incorrectly drawn in the same way. Analysis of the data, however, did take into consideration the variations in scoring systems among the three tests, as is reported upon shortly.

The experimenter and a clinical psychologist independently scored the protocols derived from the first presentation of the designs in the first experiment.

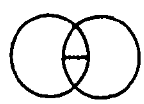
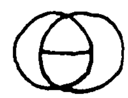
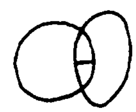
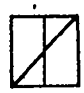
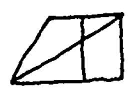
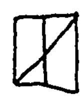


a. intersecting shapes not equal

b. gap more than 1/8 inch

c. no intersecting lines

Figure 6. Examples of McCarthy Scale drawings judged as generating the <u>same</u> incorrect copies of a given stimulus figure across testings.

STIMULUS FIGURE	McCARTHY SCALE DRAWINGS	
 6	 0 points[a]	 2 points[b]
 7	 2 points[c]	 3 points[d]

a. intersection larger than remaining portion of either shape.

b. one shape more oval than circular

c. one angle more than 90°

d. correct.

Figure 7. Examples of McCarthy Scale drawings judged as generating <u>different</u> incorrect copies of a given stimulus figure across testings.

There was a high degree of agreement between scorers as indicated by the following reliability coefficients: Bender Test, $r_{xy} = .91$, $df = 70$, $p < .01$; Benton Test, $r_{xy} = .90$, $df = 70$, $p < .01$; McCarthy Scale $r_{xy} = .81$, $df = 70$, $p < .01$.

Results and Discussion. In summary, protocols are typically scored in one of two methods, one, analysis of individual error categories such as rotation, integration, etc. (see Appendix I, II and III), and two, total number of incorrect copies. This measure is more global in that any incorrect copy may include any number of individual error categories. According to the perceptual-deficit account, one would predict a high degree of consistency both in total number of errors and types of errors generated across testing sessions, whether errors are defined as individual error categories or incorrect copies. In the following report of results, data from both methods of scoring protocols will be used. In this section, we will first begin with an analysis of incorrect copies, followed by an investigation of categories of error.

<u>Incorrect Copies</u>. Individual stability was found in the total number of incorrectly drawn figures across the two sessions for each of the three tests (Bender Test: $r_{xy} = .91$, $df = 70$, $p < .01$; Benton Test: $r_{xy} = .83$, $df = 70$, $p < .01$; McCarthy Scale: $r_{xy} = .92$, $df = 70$, $p < .01$). Moreover, there was no evidence that changes occurred in the mean total number of incorrect copies between the first (Bender Test: $\bar{X} = 5.7$; Benton Test: 5.1; McCarthy Scale: $\bar{X} = 4.3$) and second session (Bender Test: $\bar{X} = 5.8$; Benton Test: $\bar{X} = 5.0$; McCarthy Scale: $\bar{X} = 4.3$).

For the Bender figures, however, despite the consistency in total number of incorrectly reproduced figures, the results indicated that a figure did not generate the same type of incorrect copy of that figure on both occasions. Using the judgements, detailed in the procedure section for figures incorrectly reproduced in the same and different way, it was found that a given Bender figure incorrectly copied during one session was far more likely to be incorrectly copied in a different manner during the other session (Bender Test: same, $\bar{X} =$ [illegible]; different, $\bar{X} =$ [illegible]; $t\ (71) = 3.6$, $p < .01$).

Similar results were obtained not only with Benton but also McCarthy incorrect copies. A correlated

$\underline{t}$-test showed that a given Benton figure incorrectly drawn during one of the two sessions was usually incorrectly drawn in a different manner during the other session (Benton Test: same $\bar{X} = 2.1$; different $\bar{X} = 5.8$; $\underline{t}$ $(71) = 4.1$ $p < .01$). A correlated $\underline{t}$ test also indicated that a given figure incorrectly drawn during one session was likely to be drawn incorrectly in a different way during the other session (McCarthy Scale: same $\bar{X} = 2.3$; different, $\bar{X} = 4.0$, $\underline{t}$ $(71) = 2.0$ $p < .05$).

<u>Individual Error Categories</u>. The analysis of these types of errors parallel the findings with incorrect copies. Results indicated that test-retest reliability of the scoring systems was high (Bender Test: $r_{xy} = .80$, df = 70, $p < .01$; Benton Test: $r_{xy} = .82$; df = 70, $p < .01$; McCarthy Scale: $r_{xy} = .71$, df = 70, $p < .01$). Additionally, the mean scores did not change from the first session (Bender Test: $\bar{X} = 8.1$; Benton Test: $\bar{X} = 7.1$; McCarthy Scale: $\bar{X} = 11.9$) to the second session (Bender Test: $\bar{X} = 7.8$; Benton Test: $\bar{X} = 6.7$; McCarthy Scale: $\bar{X} = 11.7$). The results suggest stability in the overall number of individual error categories produced on both occasions.

For the Bender drawings, however, despite the consistency in production of total number of errors, the children did not generate the same categories of error during the two testing sessions. A correlated *t*-test indicated that there were significantly more individual error categories which occurred only in one of the two sessions ($\bar{X} = 6.2$) than were repeated across both testing sessions ($\bar{X} = 4.9$; t (71) = 1.9, $p < .05$). In other words, children who were scored for one category of error during one test usually failed to make the specific error on the other test.

Similar results were obtained for the Benton Test and McCarthy Scale. A correlated *t*-test showed that for Benton reproductions there were significantly more categories of error which occurred only in one of the two testing sessions ($\bar{X} = 8.9$) than were repeated across the two testing sessions ($\bar{X} = 2.4$; t (71) = 5.9, $p < .01$). Also in McCarthy Scale drawings there was a significant difference between the mean number of individual error categories occurring only in one of the two testing sessions ($\bar{X} = 8.0$) compared to the mean number of individual error categories repeated across the two testing sessions ($\bar{X} = 5.1$; t (71) = 4.5, $p < .01$).

The perceptual-deficit explanation of children's errors on geometric form-copying tests leads to the predictions that because errors reflect children's distorted perception of designs, children will generate the same type of incorrect copies and the same categories of error across testing sessions. The results from Experiment 1 fail to confirm these predictions. Instead, the data indicate that children are more likely to change types of incorrect copies and even individual error categories across repeated testings. Therefore, since the stimulus figures derived from the Bender Test, the Benton Test and the McCarthy Scale did not, in fact, generate the same types of incorrect reproductions and the same categories of error in both occasions, it is questionable whether such errors result from children's distorted perception of the stimulus features of designs. Further testing of the perceptual-deficit account is described in the next chapter.

CHAPTER III

EXPERIMENT 2

Hudgins (1977) has suggested testing the contention that copying errors result from children's perceptual deficits by presenting them with a multiple-choice recognition task. The child is offered three different drawings of a given figure and is asked to select a drawing that is the same as the figure. The three drawings consist of a correct reproduction of the stimulus, the child's own incorrect reproduction and another child's incorrect copy. If the child chooses his/her own incorrect copy, the view that perceptual deficits cause stable misperception of designs would be supported. If however, the correct copy is selected, it is unlikely that the errors are due to distorted perception of designs. Experiment 2 utilized this method to conduct a further examination of the perceptual-deficit explanation for children's copying errors.

Method

Subjects. The population for Experiment 2 included twelve kindergarten children who attended the same schools as the subjects in Experiment 1; but who had not participated in the latter study. These subjects consisted of seven girls and five boys. At the start of the experiment their mean age was 68.8 months, with a standard deviation of 2.9 months.

Procedure. The children were presented with two tasks in the same testing room as the subjects in Experiment 1: first, the copying task, and second, two days later, a recognition multiple-choice task. The procedures for administering and scoring the initial task were the same as those used in Experiment 1. The recognition multiple-choice test consisted of a standard figure and three choices. One of these choices was the subject's own incorrect drawing of the stimulus produced during the copying test two days previously, the second choice was another child's correct copy, and the third choice was another child's incorrect copy. The last two groups of protocols were obtained from a pool of drawings produced by the kindergarten children used in Experiment 1.

A sample item of the recognition-multiple choice test is presented in Figure 8. This figure also describes the standard positioning of the test on the table. The drawings used as choices were each stapled to separate white index cards the same size as those containing the stimulus figures (20.3 x 13 cm), which were from the same note book and presented in a similar

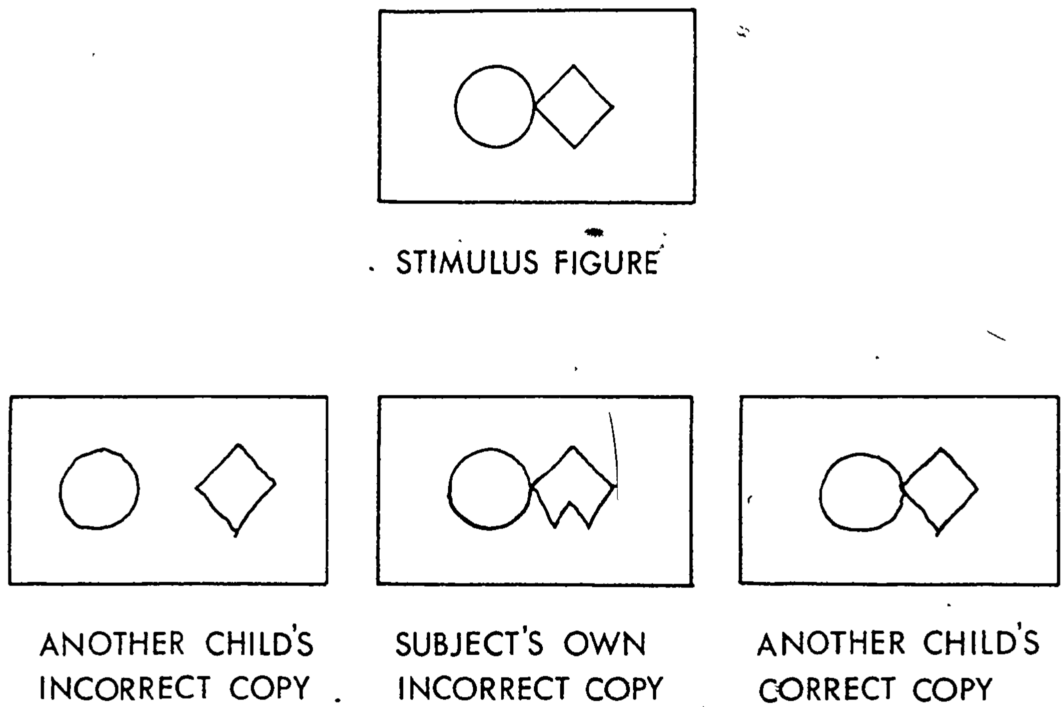


Figure 8. Sample of stimulus figure and three choices. Note that the drawings above are representative of the standard positioning of the cards as presented in the experiment.

manner as the one used during the copying test two days earlier.

The child presented with the recognition multiple-choice test was asked to select the design which looked exactly like the standard, indicating his/her selection by pointing. Each child was presented the task six times, with two representations (i.e. standard figure and choices) from the three tests, the Bender Test, the Benton Test and McCarthy Scale. The order of the representations and the sequencing of the choices presented were randomized.

Results and Discussion. The scores on the copying test part of Experiment 2 indicated that the twelve children generated similar number of errors as reported for Experiment 1. The scores for the second experiment were: Bender Test: $\bar{X} = 8.5$; Benton Test: $\bar{X} = 6.9$; McCarthy Scale: $\bar{X} = 11.6$. The scores for the multiple-choice task were also computed.

Out of the six presentations of the task children chose, on average, the protocol with the correct copy 74% of the time (4.4 out of 6 presentations) and the protocol with the child's own incorrect copy 13% of the time. (.8 out of 6 presentations) and another child's incorrect copy 13% of the time (.8 out of 6 presentations). A Wilcoxon Test indicated that children chose the protocols with the correct copy significantly more often than the child's own incorrect copy ($T = 0$, $df = 11$, $p < .01$) or another's incorrect copy ($T = 0$, $df = 11$, $p < .01$).

The perceptual-deficit account leads to an hypothesis that a child's misperception of geometric forms causes copying errors which are likely to remain stable across testing situations. If this is so, then the child is also likely to consistently misperceive the stimulus features of designs whether they are presented in copying tasks or in multiple-choice recognition tasks. The results of Experiment 2, however, show that children do in fact discriminate between a correctly drawn copy and their own incorrect copy of a stimulus. The same child who has generated a copying error from a stimulus design do not regard that incorrect copy as equivalent to the stimulus presented several days later. Thus the findings of Experiment 2 suggest that copying errors do not stem from a child's intrinsic and stable misperception of designs.

The first two experiments, which analyzed children's production of errors in different ways, both present evidence against the prevalent contention that errors result from perceptual deficits. In Experiment 1 it was found that children did not generate the individual error category nor the same type of incorrect copy during repeated testings, while Experiment 2 found that children who made errors in copying tasks can later select protocols that correctly match the stimulus features of the same geometric forms. In light of these findings, which failed to validate perceptual-deficit account, an alternative explanation for children's copying errors must be sought. An examination of attention factors are therefore presented in the next chapter, to further explore possible reasons for children's difficulties in copying tests.

CHAPTER IV

Experiment 3

In contrast to the perceptual-deficit account, the attention explanation suggests that children's copying errors stem from momentary lapses in attention, possibly due to their distractibility. If the alternate account is correct, then focussing children's attention on the general properties of designs should result in fewer errors, whereas distracting their attention should produce an increase in errors. This chapter discusses the manner in which such predictions were tested in three separate studies.

In the first study, Experiment 3a, children in one group had their attention focussed on the designs by reinforcing them for correct copies, while another group had their attention distracted from the designs. Distraction was accomplished by asking each child to copy designs on sheets containing moderately dense criss-crossing lines, shown in Figure 9, which is modified from Canter's (1963) Background Interference Procedure.

In Experiment 3b, attention was focussed on the stimulus designs of geometric form-copying tests by asking each child to describe verbally the general

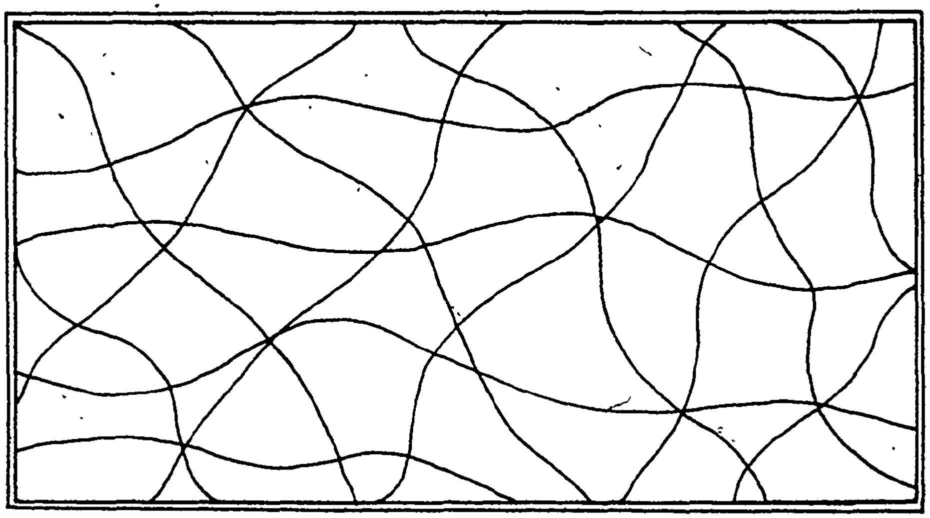


Figure 9. Facsimile of response sheet containing moderately criss-crossing lines.

properties of the designs before reproducing them. Simner (1979) found that this manner of manipulating a child's attention resulted in fewer errors. It is possible, however, that the improved performances could be due to verbal mediation rather than attention factors <u>per se</u>. While Simner's method was utilized in Experiment 3b, it was recognized that the study might not be a 'pure' method of focussing attention. Consequently it was separated from the first study.

The final study, Experiment 3c, investigated the relationship between teachers; ratings of children's distractibility and children's production of errors as scored for Experiment 1 protocols. Simner (1979) found that children who were rated highest in distractibility tended to produce the highest number of copying errors. An examination of results could provide another method of testing the attention explanation of children's copying errors.

<u>Method and Procedure</u>

<u>Experiment 3a</u>. Fifty-four children who also took part in Experiment 1 participated in Experiment 3a, in the same testing room that the children were familiar with. The experiment occurred two weeks after testing for

Experiment 1. The same methods as those of Experiment 1 were used with reference to standard size and positioning of the cards. Also the number and types of figures were exactly the same as in Experiment 1.

Children were randomly assigned to one of three groups of eighteen subjects each, and the three groups were assigned to three separate experimental conditions: Focussed Attention (hereafter referred to as F.A.), Distracted Attention (D.A.) and Control (C). The same administrative method used for Experiment 3a was utilized for Experiment 1, with the only exceptions noted below.

Before the start of the experiment, the subjects who received condition F.A. were told that they would be asked to copy the figures they had encountered in Experiment 1, but that they should take particular care with their drawings and would receive a coloured star for each correctly drawn shape. It was also explained to them that the child with the most stars would receive a prize, a toy jumping frog which was shown immediately after the instructions were given. Furthermore, as the children produced each correct copy they were immediately reinforced with verbal praises such as 'very good', 'good boy/girl', etc. prior to the star being affixed to an index card containing the child's name. This card was visible to the child throughout the experiment.

The subjects who received condition D.A. were told that they would be asked to copy the familiar figures in the same way as before, except that the paper on which they were to draw each design would have lines. Figure 9 presents a facsimile of the response sheets containing moderately dense criss-crossing lines. The subjects who received condition C were simply instructed to copy the designs in the same way as before and the response sheets they used were the standard blank ones.

Experiment 3b. This study, conducted concurrently with Experiment 3a, used the eighteen remaining children of the original group of seventy-two who had participated in Experiment 1. Instructions given to the children specified that they were to describe each design to the experimenter, and then copy it on separate response sheets. The subjects' verbal descriptions were recorded on a cassette tape recorder. The purpose of these recordings was to facilitate further analysis as reported upon below. The administration of designs, response sheets, testing room and scoring of protocols was the same as Experiment 3a.

Experiment 3c. In this study, the correlational part of Experiment 3, the kindergarten teachers were asked to rate their respective children's typical level of distractibility in the classroom. The rating scale used by teachers ranged from one to ten, with the lowest number indicating poorest attention span in the classroom and the highest numbers indicating increasingly good attention span.

The ratings were then correlated with the scores children received during the first administration of the three tests in Experiment 1.

For all three studies, the dependent measure was the scores children received as defined by the individual standard scoring systems of the three tests.

Results and Discussion. In brief review, Experiment 1 consisted of administering a set of twenty-eight designs to kindergarten children, and then repeating the administration several days later. Scores of Experiment 3a and 3b were both compared to the scores obtained on the second administration of Experiment 1.

Experiment 3a. The results of Experiment 3a provided support for the attention account. Table 1 presents the mean scores by test for all three experimental conditions (F.A., D.A., and C.) for both the

TEST	CONDITION	Presentation: Second Administration Experiment 1	Presentation: Experiment 3a
Bender	F.A.	8.3	4.7
	D.A.	8.0	11.0
	C	8.2	8.1
Benton	F.A.	7.1	4.8
	D.A.	6.8	10.0
	C	7.1	6.8
McCarthy*	F.A.	11.9	14.4
	D.A.	12.0	8.9
	C	11.8	11.8

Table 1. Experiment 3a.

Means score by test, condition and presentation. (F.A.-Focussed Attention, D.A.-Distracted Attention, C.-Control).

* In the McCarthy Scoring System the higher the score the better the performance.

second administration of Experiment 1 and for Experiment 3a.

A 2 x 3 ANOVA (presentation x condition) with repeated measures on presentation was computed separately for each of the three tests and significant main effects for conditions were identified for each test (Bender Test: $F\ (2,68) = 9.4$, $p < .001$; Benton Test: $F\ (2,68) = 6.8$, $p < .01$; McCarthy Scale: $F\ (2,68) = 12.9$, $p < .001$). The presentation x condition interaction was also significant for each test (Bender Test: $F\ (2,68) = 11.3$, $p < .001$; Benton Test: $F\ (2,68) = 5.9$, $p < .01$; McCarthy Scale: $F\ (2,68) = 14.0$, $p < .001$).

A Newman-Keuls analysis of the difference between the means showed that children in the F.A. group made significantly fewer errors in Experiment 3a, on each of the three tests. Conversely, children in the D.A. group produced significantly more errors in Experiment 3a, on each of the three tests, again using their scores from the second administration of Experiment 1 as the baseline. Children in the Control group displayed no change between the two studies. Thus the results of the analysis of Experiment 3a data seem to verify the predictions derived from the attention account. Focussing attention on the designs significantly reduced copying errors, while distracting attention significantly increased such errors.

Experiment 3b. The results of Experiment 3b are also consistent with those of Experiment 3a. Table 2 presents the mean scores by test for both the second administration of Experiment 1 and Experiment 3b. The comparison indicates that children made significantly fewer errors on each of the three tests during Experiment 3b.

It would seem, moreover, that this improvement resulted from the attention that was experimentally manipulated rather than by the quality of the description *per se.* To examine this factor, ten of the children's taped descriptions were fully transcribed, and then read back to each subject who was asked to use his/her own descriptions to redraw the figures, one at a time. Analysis of the two-hundred-and-eighty redrawn designs indicated that only twenty-two drawings (less than five percent) matched the original copy whether reproduced correctly or incorrectly during Experiment 3b. These results suggest that the descriptions themselves were not crucial to error reduction. Instead, the attention required to generate the descriptions were likely the key factor. Simner (1979) reported similar findings, and noted that correct reproductions of letters

Test	Presentation	
	Second Administration Experiment 1	Experiment 3b
Bender	8.2	6.4*
Benton	7.5	5.0**
McCarthy	11.9	13.6***

*t (17) = 2.76, p .05

**t (17) = 3.47, p .01

***t (17) = 2.79, p .05

Table 2. Experiment 3b.
A comparison of mean scores by
test and presentation.

occurred on most occasions even when children misnamed the letters prior to copying.

Experiment 3c. For Experiment 3c, the correlation between teacher ratings of children's distractibility/attentiveness in the classroom and the children's scores on the first administration of Experiment 1 was: Bender Test $r_{xy} = .78$, $df = 70$, $p < .01$; Benton Test: $r_{xy} = .60$, $df = 70$, $p < .01$; McCarthy Scale: $r_{xy} = .40$, $df = 70$, $p < .01$. The results suggest that those children who are rated as least attentive tend to produce errors most frequently on geometric form-copying tests. Such correlations offer further evidence in support of the attention explanation for children's copying errors, which suggests that the manipulation of attention and distractibility are significant factors.

While the primary objective of studies in Experiment 3 was the investigation of the attention account, the findings are also a further test of the perceptual-deficit hypothesis. As pointed out in the Introduction, those who support this account (e.g. Koppitz, 1975) argue that copying errors are due to inherent inabilities to reproduce the designs accurately, and not to a failure to apply efficiently capabilities which may be present in the child. They would therefore predict that manipulation of capabilities (such as attention) should have relatively little effect on kindergarten children's performance on geometric form-copying tests.

Experiment 3a demonstrated that manipulation of attention by reinforcement of correct copies and distraction by the use of response sheets containing extraneous cues did indeed affect children's copying competence. The findings of Experiment 3b showed that manipulating attention by requiring verbal descriptions prior to execution of copying tasks did in fact reduce copying errors. Experiment 3c demonstrated that children who are most distractible tend to produce the most errors. Thus the studies in Experiment 3 not only lend further reason for questioning the validity of the perceptual-deficit account, but also present evidence in support of the attention-account. In the next chapter, a fourth and final experiment, further examines the manipulation of children's attentiveness and the effects upon geometric form-copying test performance.

CHAPTER V

Experiment 4

The previous experiment provided evidence that children's incorrect reproductions from geometric form-copying tests may well result from attention problems, and not from inherent perceptual deficits, a conclusion derived from research with non-disabled children. The perceptual-deficit explanation also contends, however, that incorrect reproductions by learning disabled children stem from perceptual and/or neuorological deficits (Cruickshank, 1972; Koppitz, 1971). The prevalent explanation therefore predicts that learning-disabled subjects will generate not only the same number of incorrect copies but also generate the same type of incorrect copy across testing sessions. This account also predicts that these children should produce the same number of errors as well as the same categories in repeated testing sessions. Experiment 4 reported on in this chapter, investigated these predictions.

The first part of the experiment tested the perceptual-deficit account by investigating learning-disabled children's copying errors in two test administrations, using the same procedure selected for Experiment 1. Scoring was again tabulated first, on the basis of incorrect copies, and second, according to categories of error. The second part tested the attention-hypothesis but with reference to learning disabled children, utilizing methodology similar to Experiment 3a. Children's attention was focussed on the general properties of the designs by reinforcing them for each correct copy in order to investigate the claim of the attention-account that such manipulation would reduce errors. Similarly, distraction of attention through the use of extraneous cues on response sheets was used to test the attention-explanation prediction of increased errors.

Method

Subject. The initial population consisted of twenty-seven children from one of two clinical settings in London, Ontario: the private practice of a clinical psychologist, and an annual summer learning clinic for children with academic problems, supervised by special education faculty members affiliated with the University of Western Ontario. As with the seventy-two children participating in the first three experiments, written parental permission was obtained prior to testing the subjects in Experiment 4.

There were two additional criteria for inclusion of subjects in the study. The first was that the children had to have test scores at least two grades below age levels on formal reading and/or arithmetic achievement tests. These scores were obtained from records available in the two clinical settings. Secondly, the children had to score one standard deviation above expectations for their age levels on the Bender Test, using the Developmental Scoring System (Koppitz, 1975), where the higher the measured score, the lower the performance. This criterion was determined during the first administration of stimulus designs in Experiment 4.

Based on these criteria, most clinicians would diagnose such a child as both learning-disabled and as deficient in visual-motor perception (Bryan and Bryan, 1978; Bush and Waugh, 1976). It should be noted that the Bender is the preferred copying test for diagnosis of perceptual deficit (Tarnopol, 1969).

Of the twenty-seven children initially selected, twenty (twelve boys and eight girls) met the criteria specified above, and participated in both parts of Experiment 4. The mean age of the qualifying subjects was 8.6 years, with a range from 7.8 to 11.8 years.

I.Q. scores, derived from the WISC-R were available for fifteen of the twenty children, with the mean at 105.5 (Full Scale) and standard deviation of 12.4. None of the children had any apparent emotional or physical handicap, and all were tested in their own homes in a quiet area with few distractions.

Procedure. In the first part of Experiment 4, subjects were presented with selections from the Bender, the Benton and the McCarthy Scale on two different occasions, separated by a one to four day lapse, in order to investigate whether children's alleged misperceptions remained constant. The selection of stimulus designs was the same as utilized in Experiment 1 (see figure 1) and the same alternating sequence was utilized with two randomly divided groups of ten children each. In addition, the instruction, procedures and scoring systems used in Experiment 1 (see Chapter Two) were also applied in Experiment 4.

The second part of Experiment 4 began one to four days after the test-retest administrations of the first part. Using the same random grouping of subjects established at the onset of the study, one group was first presented condition F.A. (Focussed Attention) and on re-test Condition D.A., while the second group participated in the reverse order. Under condition

F.A., children received a similar procedure as that used in Experiment 3a: their attention was focussed on each design through immediate reinforcement for correct responses, including both social (verbal praise) and tangible (pennies) rewards. The pre-test instructions included informing the subjects that they should pay particular attention to the stimuli in order to obtain the pennies, which were visible throughout the session. Instructions for condition D.A. were exactly the same as used in Experiment 3a, and the same response sheets with moderately dense criss-crossing lines were used (see figure 9). A lapse of one to four days between the F.A. - D.A. and D.A. - F.A. conditions was again utilized. With the exceptions regarding place of testing and modification in procedure noted above, the methods for presentation of the stimulus designs and scoring of protocols for the second part of Experiment 4 were the same used in the previous experiments.

Results and Discussion. The first part of the experiment began with an investigation of subjects consistency in production of total number of incorrect copies as well as incorrectly reproducing the designs in the same way during the two sessions. This was followed by an analysis of whether the children consistently produced the same number of errors and category of errors across repeated presentations.

<u>Incorrect Copies</u> - As was found in Experiment 1, subjects consistently produced the same total number of incorrect copies across the two sessions for each of the three tests (Bender Test: $r_{xy} = .86$, df = 18, $p < .01$; Benton Test: $r_{xy} = .80$, df = 18, $p < .01$; McCarthy Scale: $r_{xy} = .84$, df = 18, $p < .01$). Also, there was little change in the mean number of incorrect copies produced by the subjects between the first (Bender Test: $\bar{X} = 5.6$; Benton Test: $\bar{X} = 3.7$; McCarthy Scale: $\bar{X} = 3.7$) and second session (Bender Test: $\bar{X} = 5.2$, Benton Test: $\bar{X} = 3.2$; McCarthy Scale: $\bar{X} = 4.0$).

Despite this consistency, the results revealed that a figure did not generate the same type of incorrect copy of that figure on both occasions. Using the judgements, detailed in Chapter 2, for designs incorrectly drawn in the same and different way, this result was obtained for all three tests. On the Bender test, it was found that a given figure incorrectly drawn during the one of the two sessions was more likely to be incorrectly drawn in a different manner during the other session (Bender Test: same, $\bar{X} = 2.9$, different $\bar{X} = 5.0$, t (19) $= 3.3$, $p < .01$). Similarly, a given Benton figure incorrectly reproduced during one of the two sessions was usually incorrectly drawn in a different manner during the other session (Benton Test: same $\bar{X} = 1.2$ different, $\bar{X} = 4.5$, $\underline{t}\ (19) = 3.8$, $p < .01$). A correlated $\underline{t}$-test also indicated that a given figure incorrectly copied during one session was likely to be reproduced incorrectly in a different way during the other session (McCarthy Scale: same $\bar{X} = 2.1$, different, $\bar{X} = 3.6$, $\underline{t}\ (19) = 2.2$, $p < .05$).

Individual Error Categories. Consistent with Experiment 1, test - retest reliability was high for all three geometric form copying tests (Bender Test: $r_{xy} = .84$, $df = 18$, $p < .01$; Benton Test: $r_{xy} = .84$, $df = 18$, $p < .01$; McCarthy Scale: $r_{xy} = .81$, $df = 18$, $p < .01$). There was also little change in the mean scores received by the subjects on the first (Bender Test: $\bar{X} = 7.8$; Benton Test: $\bar{X} = 4.5$; McCarthy Scale: $\bar{X} = 12.4$) and second presentation (Bender Test: $\bar{X} = 7.5$; Benton Test: $\bar{X} = 4.2$; McCarthy Scale: $\bar{X} = 12.9$). This suggests stability in the total number of incorrect copies produced in both sessions.

Despite the consistency in overall number of errors, however, comparative analysis revealed that different categories of error were generated in the two testing sessions. A t-test indicated for example, that there were significantly more categories of error from Bender Test reproductions which occurred in one of the two test sessions ($\bar{X} = 6.1$) than were repeated across both testing sessions ($\bar{X} = 4.7$, t (19) = 2.5, $p < .05$) Similar results were obtained for the Benton Test; there was a significant difference between the mean number of individual error categories occurring in one of the two testing sessions ($\bar{X} = 6.7$) compared to the mean number of errors repeated across the two presentations ($\bar{X} = 1.0$, t (19) = 6.1, $p < .01$). Also, there was a significant difference between the mean number of individual error categories on McCarthy reproductions occurring in one of the two sessions ($\bar{X} = 6.4$) compared to the mean number of individual categories of error occurring across the two testing sessions ($\bar{X} = 2.6$); t (19) = 4.2, $p < .01$).

The investigation of learning disabled children's production of errors, whether defined as individual error categories or incorrect copies, replicated the results with normal kindergarten subjects. Again there was a failure to support predictions inferred from the perceptual deficit account, since learning disabled children did not consistently produce the same type of incorrect copies or individual error categories across repeated testings. Hence this result was a further indication that errors are not tied to intrinsic properties of designs and thus unlikely to have resulted from perceptual deficits.

Analysis of the data from the second part of Experiment 4 examined the effect of manipulating children's attentiveness during copying tasks, to investigate predictions from attention explanation. Comparisons of the two alternative sequences of presentation indicate that there was no effect from sequence order; consequently, all scores under the two conditions F.A. and D.A. were collapsed in further analysis.

Children were used as their own control and their scores under conditions F.A., D.A. were compared to their scores under Condition C., the second presentation of designs in the first part of the experiment. Subjects mean scores under the three different conditions are depicted in Table 3. A one-way repeated measure ANOVA, computed separately for each of the three tests, found a significant main effect for all three (Bender Test: F (2,38) = 29.6, $p <$ .001; Benton Test: F (2,38) = 22.0, $p <$ .001; McCarthy Scale: F (2,38) = 11.2, $p <$ .001). Paired comparisons using Neuman-Keuls tests showed that children made significantly fewer errors under Conditions F.A. and significantly more

Test	Condition		
	F.A.	D.A.	C.
Bender	4.9	9.6	7.5
Benton	2.4	5.9	4.2
McCarthy*	14.9	11.6	12.9

Table 3. A comparison of mean scores by test and condition for learning disabled children, (F.A.- Focussed Attention;
D.A.- Distracted Attention;
C.- Control;
scores these subjects received during first part of Experiment 4).

*In the McCarthy Scoring system the higher the score, the better the performance.

errors under Condition D.A. when compared to the errors made in Condition C. These findings replicate the results of Experiment 3a; focussing the learning disabled child's attention produced significant reduction in errors, whereas distracting the learning disabled child's attention produced significant increased errors.

Furthermore, additional evidence against the perceptual-deficit account can be derived from these findings. As previously discussed, the subjects for Experiment 4 were selected not only because they were diagnosed as learning-disabled, but also because they scored at least one standard deviation above expected age levels on the Bender-Gestalt Test (that is, with poorer performance than normal expectations), with frequent clinical diagnosis of perceptual-deficits reflecting neurological dysfunction (Koppitz, 1975). In other words, poor performance is viewed as resulting from an inherent inability to copy designs accurately. As was mentioned earlier, Salvia and Ysseldyke (1978) in their analysis of the perceptual-deficit hypothesis, have pointed out that those who support this position would argue that the manipulations conducted in Experiment 4 should have relatively little impact on copying test performance.

To the contrary, however, Experiment 4 has demonstrated that manipulation of attention does indeed alter such children's performance. Hence, learning disabled children's copying errors do not seem to stem from perceptual-deficits, rather they may result from momentary lapses in attention, possibly due to their distractibility. This replicates the findings with the kindergarten children, detailed in the previous three experiments.

CHAPTER VI

General Discussion

The aim of the thesis was to examine two alternative explanations of children's difficulties in copying designs from geometric form-copying tests. Although copying errors are widely thought to result from children's distorted perception of the stimulus features of designs (Bender, 1938; Newcomer and Hamill, 1973; Fidel and Ray, 1972; Koppitz, 1964), it was pointed out in the Introduction that this account has not been substantiated directly (Salvia and Ysseldyke, 1978). Moreover, recent research (Brittain, 1976; Naeli and Harris, 1976; Simner, 1979) investigating young children's difficulties in copying simple designs and grade school children's printing errors suggests an alternative explanation. These studies suggest that copying errors may result from children's momentary lapses in attention due to their distractibility.

In the present work, four experiments were described that tested specific predictions from the perceptual-deficit and attention accounts. In general, the results failed to support predictions based on the perceptual-deficit interpretation, but were more consistent with an attentional account of children's errors. In Experiments 1 and 4, it was found that both normal kindergarten and learning disabled children did not consistently produce the same categories of error, nor were their incorrect reproductions of the designs the same across repeated testings. Moreover kindergarten children did not regard their own incorrect drawings as equivalents of the stimulus figure upon subsequent comparison (Experiment 2). These results suggest that errors were not tied to intrinsic properties of designs; hence, it was unlikely that these errors stemmed from children's distorted perception of the stimulus features of designs.

In fact, the experimental data indicate that incorrect reproduction may result from children's attention lapses. Various attentional manipulations used had the predicted effect on children's performance. Focussing the attention of both normal kindergarten and learning disabled children by reinforceing each correct copy significantly reduced the number of errors, whereas distracting attention by utilizing response sheets containing extraneous cues markedly increased the number of errors (Experiment 3a and 4). It was also possible to focus attention of the kindergarten children by requesting that they describe each design verbally prior to copying it (Experiment 3b). This again significantly reduced copying errors regardless of the accuracy of such descriptions. Furthermore, kindergarten children with high teacher ratings of distractibility tended to produce the greatest number of errors (Experiment 3c).

The traditional use of geometric form-copying tests to diagnose and prescribe remediation in visual-perceptual areas is therefore seriously questioned. It is suggested that such tests may be more efficacious in the diagnosis of attentional problems. In other words, poor performance on these tests which has been interpreted as an indication of perceptual handicaps may, in fact, indicate difficulties in maintaining attention.

These findings suggest one possible reason why perceptual training programs have not produced the results anticipated. Extensive reviews (Hallahan and Cruickshank, 1973; Hammill, 1972; Hammill, Goodman and Wiederhort, 1974) of studies evaluating the effects of perceptual-motor remediation on academic skills, have found little, if any, evidence that such training helps children overcome their learning and academic problems. The reviewers add that those few studies reporting gains following perceptual-motor remediation suffer from serious methodoligical problems such as statistical errors, limited number of subjects and poor or no control groups. It was pointed out in the Introduction that poor performance on geometric form-copying tests usually results in the prescription of perceptual-motor activities (Zach and Kaufman, 1972). The present data, however, suggest that difficulties in copying designs may result from lapses in attention rather than perceptual deficits. Children who are participating in perceptual training programs may, in reality, have attention difficulties. Consequently, perceptual remediation fails to meet their needs and thereby produces little change in their academic abilities.

The failure of perceptual remediation programs might be due to incorrect diagnosis not only on the basis of geometric form-copying tests but also other perceptual-motor tests. Questions have been raised as to the diagnostic validity of such commonly used instruments as the Frostig Development Test of Visual Perception (Frostig, 1961) and the Illinois Test of Psycholinguistic Abilities (I.T.P.A., Kirk and McCarthy, 1968). Vellutino, Steger, Moyer, Harding and Niles (1977), in their review of factor analytical investigations of these tests, found that they do not have sufficient factorial validity to be employed as diagnostic measures. They state "It has been demonstrated that subtests are so highly intercorrelated that they cannot be used to uncover deficiencies in the variety of functions they are intended to measure" (p.380). Zach and Kaufman (1972) describe a dissertation by Heuftle (1967) who factor analyzed the Frostig Scale and discovered that two seemingly overlapping and multi-dimensional factors were being tapped: one of these factors appeared to be a "perceptual" component and the other one was the ability to understand and follow directions. Hence it seems inappropriate to use the subtests of these instruments to prescribe remediation in specific perceptual-motor activities when it is unclear what exactly these subtests measure. In other words, children might be undergoing training in areas they may, in the first place, not need.

Given the ambiguity of what the subtests of such commonly used perceptual-motor instruments as the <u>Frostig</u> and <u>ITPA</u> measure, it would seem reasonable to ask whether the attention-account might be extended to explain children's performance on these other tasks. The research presented in this thesis clearly indicates that a so called "perceptual" test (geometric form-copying tests) does not measure visual-perceptual processes but rather the ability to maintain attention "on task." One subtest of the Frostig, in fact, seems quite amenable to explanation by the attention-account. The "spatial relation" subtest requires children to copy simple figures using dots as guide points. In view of the present experimental data with even more complex designs, problems on this task might simply be due to lapses in attention. Furthermore, it would be interesting to investigate the effects of manipulating children's attention on children's performance on other subtests, using methods presented in the thesis. For example, children could be reinforced for correct responses on the "position in space" and/or "figure-ground" subtests of the Frostig. The former task requires children to discriminate between reversed and rotated schematic drawings of common objects presented in series, the latter one asks children to "perceive" the figures against increasingly complex grounds. If reinforcement products a significant improvement in children's performance on the two tasks, an alternative explanation for their difficulties might be found in the attention-account rather than the usual interpretation of deficits in these specific visual-perceptual processes. Future research will be conducted to determine the possibility of using the attention-account to explain children's performance on other widely used perceptual-motor tests.

There are still serious questions as to the diagnostic validity of the instruments commonly used to prescribe remediation in perceptual areas. Such remediation, moreover, has proven ineffective in ameliorating children's learning and academic dysfunctions. As discussed in the Introduction, further complicating matters is the variety of ways clinicians define "perceptual processes" (Hammill, 1972). There are also theoretical reasons to question the perceptual-motor practice of assessment and remediation. Ross (1976) has pointed out that this practice is based on unwarranted generalizations from research with brain-damaged adults to intact but learning disabled children (for further detail see Hallahan and Cruickshank, 1973). Vellutino et al (1977) have suggested that the perceptual motor practise is based on misinterpretations of Piagetian concepts, unsubstantiated positions such as Gestalt theory and mistakingly viewing 'perception' as a process rather than as an abstract and generic team. Hence in agreement with others (Zach and Kaufman, 1972), we must caution educators and clinicians against haste in designating children as perceptually handicapped. There may be merit in the argument of some investigators (Larsen, Rogers and Sowell, 1976) for a complete moratorium in attempts to diagnose children as perceptually handicapped especially with the instruments now in use.

The present findings, however, do fit well with research emphasizing attention and distractibility factors in learning and academic problems. Ross (1976) and others (Hallahan 1975; Hallahan and Reeve, 1980; Tarver and Hallahan, 1974) have suggested that attentional problems are important psychological correlates of children at risk for school failure and/or learning disabilities. In other words, what might appear to be learning deficit in these children could, in reality, stem from children's difficulty in maintaining their attention when confronted with the normal distractions found in the academic setting. These investigators have suggested that one direction in remediation should be training in helping children to focus their attention on the relevant stimuli or required tasks and/or to ignore extraneous information. For remediation in this direction, they have recommended the use of such programs as cognitive behaviour modifications (Meichenbaum, 1977), Strauss and Lehtinen isolation procedure (Strauss and

Lehtinen, 1947) and behaviour modification techniques such as Staat's (1968) reinforcement training. All these programs emphasize training in maintaining attention "on task" and have proven effective in helping children overcome some of their academic and learning problems (Becker and Carnine, 1980; Cameron and Robinson, 1980; Douglas, Parry, Marton and Garson, 1976; Hallahan and Cruickshank, 1973; Hallahan, Gajar, Cohen and Tarver, 1978; Jenkins, Garrofa and Griffiths, 1972; Staats, Minke, Goodwin and Landeen, 1970).

Geometric form-copying tests, in light of the present research findings, might be one of the formal instruments by which children are identified and prescribed the attention training programs just described. These tests may be particularly useful in this regard since they usually take only 10-15 minutes to administer and score (Benton, 1964; Koppitz, 1975). Moreover, the non-verbal nature of these tests make them attractive with even young children who may display language immaturities (Koppitz, 1964).

Whether geometric form-copying tests do, in fact, become a major tool in the diagnosis and remediation of attentional areas will obviously depend on future research especially of the kind that extends the present finding to other normal and clinical populations not sampled in the thesis. Research should be pursued replicating the four experiments using older normal children and also young children at risk for school failure. Although most of the experiments in the thesis involved kindergargen children, few of them were at risk for school failure. Another interesting population that could be involved in this suggested research are mentally retarded children. These individuals are in fact frequently administered geometric form-copying tests and their usual poor performance is commonly attributed to perceptual deficits (Koppitz, 1964). The results of this proposed research thus may provide further clarification of the perceptual deficit and attentional accounts of errors on geometric-form copying tests. It might also further define the suitability of geometric form-copying tests as instruments diagnosing and prescribing remediation that emphasize training in attentional skills.

APPENDIX I. The Developmental Scoring System for the Bender-Gestalt from Koppitz (1975).

Definition and Examples of Scoring Items

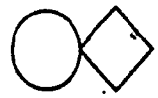
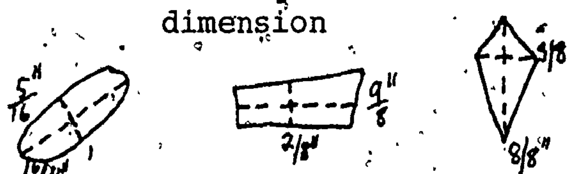


Figure A

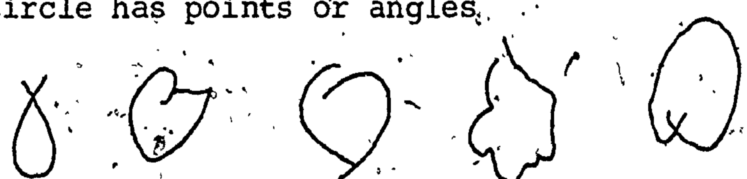
1. Distortion of shape:

   a) Circle or square or both are excessively misshapen

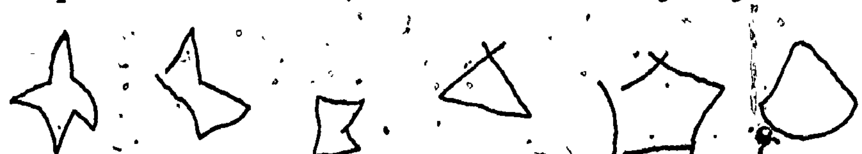
   Examples: Longest dimension of circle or square is twice as long as the shortest dimension



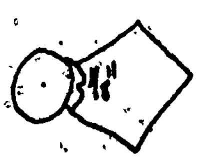
Circle has points or angles



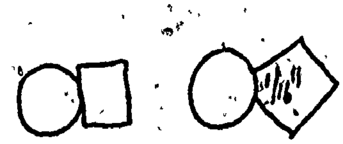
Square has "ears", extra or missing angles



Two sides of a corner of the square are more than 1/8" apart at point of junction with circle.



scored



not scored

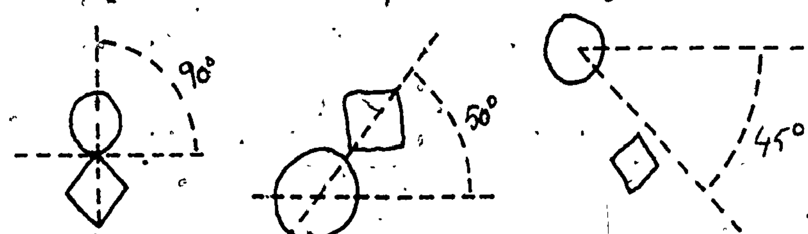
b) Disproportion between size of circle and square: area of one is at least twice as large as area of the other

Examples:

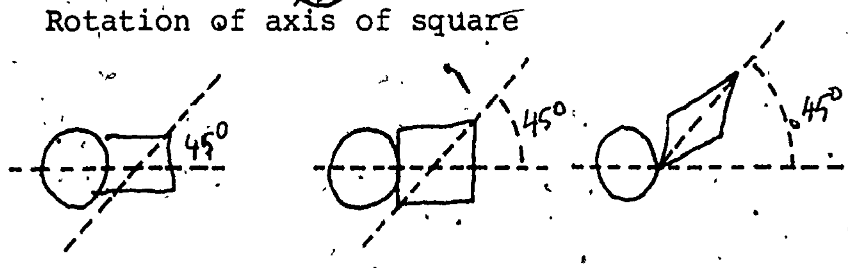
2. Rotation

Rotation of total figure or part of it by 45° or more

Examples: Rotation of total figure



Rotation of axis of square



3. Integration

Failure to join circle and square, circle and adjacent corner of square more than 1/8" apart; this applies also to overlap

Examples:

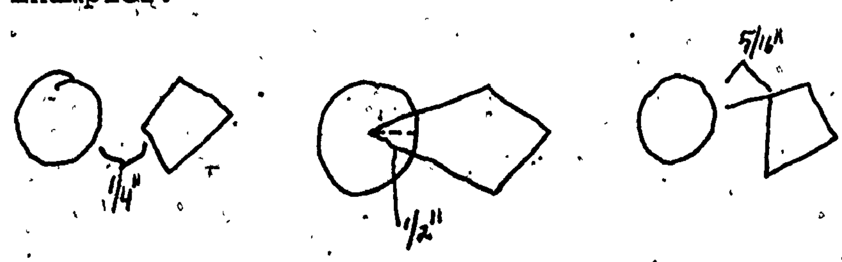
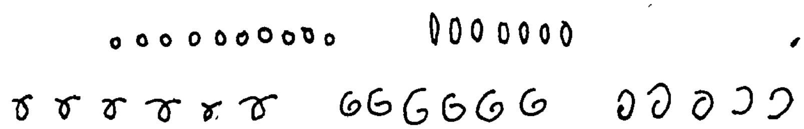


Figure 1

4. Distortion

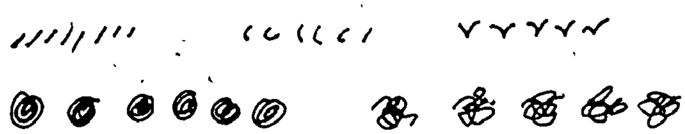
Five or more dots converted into circles. Circle is defined as an open space surrounded totally or almost completely by a line

Examples: Scored



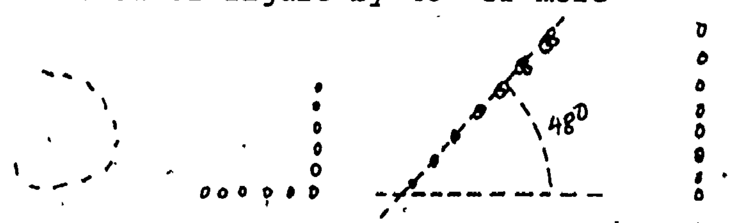
Enlarged dots or partially filled circles, dashes, and curves are not scored; in case of doubt do not score.

Examples: Not scored



5. Rotation

Rotation of figure by 45° or more



6. Perseveration

More than 15 dots in a row.

Example:

APPENDIX II. Revised Visual Retention Test Scoring System from Benton (1974).

The Two Scoring Systems

Scoring of the Visual Retention Test is objective and is accomplished on the basis of explicit principles. Interscorer agreement has been found to be extremely high (r = .95) with respect to total scores, and satisfactory (r = .75-.98) with respect to major categories of errors (Wahler, 1956). Two scoring systems are available for the evaluation of subjects' performances. One, Number of Correct Reproductions, provides a measure of general efficiency of performance; the other, Error Score, takes account of the specific types of errors made by the subject.

Number of Correct Reproductions

Each design is judged on an all-or-none basis and given a score of 1 or 0. Therefore, the range of possible scores for any single form of the test is from 0 to 10.

The principles underlying the scoring of each design of Forms C, D, and E, together with samples of correct and incorrect reproductions, are presented on pages 12-41. The scoring standards are rather lenient because one is interested in the subject's capacity to retain a visual impression and not in his drawing ability. Thus, the size of the reproduction as a whole, as compared with the original design, is not considered in the scoring. However, within a specific design, the relative size of the figures (as compared with each other) is taken into account.

Error Score

In any less-than-perfect performance on a design, one or more specific types of errors are necessarily made by the subject. The Error Score system of evaluation classifies errors by type, and provides for a total Error Score. This system, in addition to providing a measure of general efficiency of performance, facilitates analysis of the qualitative characteristics of a subject's performance.

The specific types of errors which may be made have been grouped into six major categories: omissions, distortions, perseverations, rotations, misplacements, and size errors. The complete scoring system is as follows:

OMISSIONS (AND ADDITIONS)

SYMBOL	DEFINITION
M	Omission of the single major figure of Design I or II: scored when the figure is completely omitted or when the subject draws only one or two lines which are not a recognizable attempt to reproduce it.
MR	Omission of a right major figure (i.e., in the subject's right visual field); scored when the figure is completely omitted, space being provided for it in the reproduction, or when the subject draws only one or two lines which are not a recognizable attempt to reproduce it.
MR!	Omission of a right major figure; scored when the figure is completely omitted, no space being provided for it in the reproduction.
ML	Omission of a left major figure; scored in the same manner as MR.
ML!	Omission of a left major figure; scored in the same manner as MR!
PR	Omission of a right peripheral figure.
PL	Omission of a left peripheral figure.
Add	Drawing of an additional figure not present in the original design and not scorable as a distortion (multiple reproduction) or a perseveration.

DISTORTIONS

SYMBOL	DEFINITION
SM	Inaccurate reproduction of the single major figure of Design I or II by simple substitution (e.g., square for oblique parallelogram; pentagon for hexagon).

SYMBOL	DEFINITION
SMR	Inaccurate reproduction of a right major figure by simple substitution (e.g., circle for square; pentagon for triangle).
SML	Inaccurate reproduction of a left major figure by simple substitution; scored in the same manner as SMR.
SPR	Inaccurate reproduction of a right peripheral figure by simple substitution.
SPL	Inaccurate reproduction of a left peripheral figure by simple substitution.
IM	Inaccurate reproduction of the single major figure of Design I or II in some manner other than simple substitution or rotation (e.g., omission, addition, or misplacement of an internal detail of the figure, fragmentation of the figure, multiple reproduction of the figure).
IMR	Inaccurate reproduction of a right major figure in some manner other than simple substitution or rotation; scored in the same manner as IM.
IML	Inaccurate reproduction of a left major figure in some manner other than simple substitution or rotation; scored in the same manner as IM.
IMC	Inaccurate reproduction limited to the central overlapping area of the major figures in Design III of Form C or D.
IPR	Inaccurate reproduction of a right peripheral figure in some manner other than simple substitution or rotation (e.g., fragmentation or multiple reproduction of the figure).
IPL	Inaccurate reproduction of a left peripheral figure in some manner other than simple substitution or rotation.

PERSEVERATIONS

A perseveration is a simple substitutive or additive response consisting of the reproduction of a figure present in the immediately preceding design. If the perseverated figure is drawn on consecutive succeeding reproductions, it is scored as a perseveration each time it is drawn. (For example, if a subject draws a circle for the left major figure of Design V of Form C, this is scored as a perseveration since the circle appears as the left major figure of Design IV. If the subject also draws circles for the right major figures of Designs VI and VII, they are also scored as perseverations since they appear to relate back to the presentation of Design IV.) Perseveration is also scored when a peripheral or major figure is drawn so that it is identical with a major figure in the same design. When perseveration is scored, no other type of substitutive or additive error is scored for the same figure. Nor is a rotational error scored if the perseverated figure is rotated. However, a misplacement or size error can be scored for the figure.

SYMBOL	DEFINITION
PerM	Perseveration on Design II of the figure presented in Design I.
PerMR	Perseveration in the drawing of a right major figure.
PerML	Perseveration in the drawing of a left major figure.
PerPR	Perseveration in the drawing of a right peripheral figure.
PerPL	Perseveration in the drawing of a left peripheral figure.

ROTATIONS

SYMBOL	DEFINITION
180M	A plane rotation of approximately 180 degrees of the single major figure of Design I or II.
90M	A plane rotation of approximately 90 degrees of the single major figure of Design I or II.

SYMBOL	DEFINITION
45M	A plane rotation of 25 to 65 degrees of the single major figure of Design I or II (but see StM, below).
StM	A plane rotation of approximately 45 degrees of the single major figure of Design II, when a figure resting on an angle is drawn as resting on a side.
180MR	180-degree plane rotation of a right major figure.
180ML	180-degree plane rotatio of a left major figure.
90MR	90-degree plane rotation of a right major figure.
90ML	90-degree plane rotation of a left major figure.
45MR	45-degree plane rotation of a right major figure (But see StMR, below).
45ML	45-degree plane rotation of a left major figure (but see StML, below).
StMR	45-degree plane rotation of a right major figure, when a figure resting on an angle is drawn as resting on a side.
StML	45-degree plane rotation of a left major figure, when a figure resting on an angle is drawn as resting on a side.
180PR	180-degree plane rotation of a right peripheral figure.
180PL	180-degree plane rotation of a left peripheral figure.
90PR	90-degree plane rotation of a right peripheral figure.
90PL	90-degree plane rotation of a left peripheral figure.
45PR	45-degree plane rotation of a right peripheral figure.

SYMBOL	DEFINITION
45PL	45-degree plane rotation of a left peripheral figure.
Mir	180-degree rotation in space (mirror-imaging) of an entire design.
MirMR	180-degree rotation in space (mirror-imaging) of a right major figure.
MirML	180-degree rotation in space (mirror-imaging) of a left major figure.
180MR(Mir)	Rotation of a right major figure scorable as either a 180-degree plane rotation or a 180-degree rotation in space (mirror-imaging).
180ML(Mir)	Rotation of a left major figure scorable as either a 180-degree plane rotation or a 180-degree rotation in space (mirror-imaging).
90MR(Mir)	Rotation of a right degree figure scorable as either a 90-degree plane rotation or a 180-degree rotation in space (mirror-imaging).
90ML(Mir)	Rotation of a left major figure scorable as either a 90-degree plane rotation or a 180-degree rotation in space (mirror-imaging).
VerM	Rotation of the horizontal axis through major figures; scored when one major figure does not extend across the mid-line of the other.

MISPLACEMENTS

Misplacements are various types of distortions of the spatial relationship between the figures of a design. Only one misplacement error is scored for any single design.

SYMBOL	DEFINITION
Rev	Left-right reversal of the relative positions of the two major figures.
NOv	Reproduction of overlapping major figures as nonoverlapping.
Ov	Reproduction of noncontiguous figures as contiguous or overlapping.

SYMBOL	DEFINITION
WOv	Reproduction of overlapping major figures as overlapping at the wrong juncture.
MisPR	Misplacement of a right peripheral figure so that it is to the left of, between, within, above, or below the major figures.
MisPL	Misplacement of a left peripheral figure so that it is to the right of, between, within, above, or below the major figures.
UPR	Displacement of a right peripheral figure upward.
UPL	Displacement of a left peripheral figure upward.
DPR	Displacement of a right peripheral figure downward.
DPL	Displacement of a left peripheral figure downward.

SIZE ERRORS

SYMBOL	DEFINITION
SzMR	Distortion in the relative size of the right major figure; scored when the height of the right major figure is less than 3/5 the height of the left major figure, both figures being measured at the point of maximal height.
SzML	Distortion in the relative size of the left major figure; scored in the same manner as SzMR.
SzPR	Distortion in the relative size of the right peripheral figure; scored when the height of the peripheral figure is greater than 3/5 the height of the larger of the two major figures, all figures being measured at the point of maximal height.
SzPL	Distortion in the relative size of the left peripheral figure; scored in the same manner as SzPR.

In using the Error Score System, one sometimes encounters an incorrect response which can be scored in more than one way. The following examples illustrate this situation.

a. When an incorrect placement of an internal detail can be scored either as a rotation or as a distortion, in the interest of consistency, the convention of scoring these errors as rotations has been adopted. Of course, the response must clearly satisfy the criterion of a rotational error that further rotation of the figure would result in a correct reproduction.

b. When a response can be scored either as a plane rotation or as a rotation in space (mirror-imaging), the scoring system provides specific symbols for this type of reproduction (e.g., 180MR Mir , 90ML Mir). The specificity of this designation will permit the examiner who is particularly interested in mirror-image reproduction to take account of these responses.

Other aspects of the Error Score system which warrant emphasis are the following:

c. Only one misplacement error is scored for any single figure (e.g., if a lower right peripheral figure is reproduced in the upper left corner, it is scored as MisPR, without account being taken of its upward displacement).

d. When the reproduction of a figure is scored as a perseveration, a misplacement or size error can also be scored, if warranted, but a substitutive, additive, or rotational error should not be scored for the figure.

e. Difficulty in deciding whether a peripheral figure is too high or too low in relation to the major figures may be encountered when the major figures themselves are drawn in different sizes, on different levels, or on an axis which is not parallel to the edges of the paper. Judgement of the peripheral figure should be based on lines

Thus, the six major scoring categories contain a total of 64 specific errors. It will be noted that the division of errors as they apply to right, left, and central figures more than doubles the number of specific errors. Actually, there are 27 fundamental error-types.

The principles of scoring and the sample reproductions on pages 12-41 may be used as a guide when scoring by the Error Score system. For each sample of an incorrect reproduction, the specific errors are indicated directly under the faulty drawing. An incorrect reproduction may include as many as 4 or 5 specific errors. Theoretically, the possible range of total Error Scores for a single form of the test is very wide. In practice, however, one finds the upper limit to be about 24 errors.

At first glance, it may seem that the Error Score system is inordinately detailed and time-consuming, but this has not proved to be the case. Examiners with relatively little scoring experience can accurately score a record containing a fair number of errors in about five minutes.

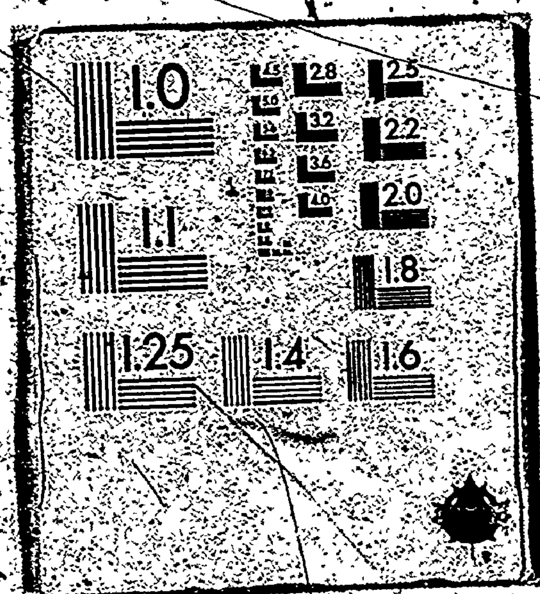
Scoring, recording, and interpretation are facilitated by the use of the Visual Retention Test Record Form. On this sheet, the subject's performance is summarized not only in terms of the total number of errors and the number of errors in each of the six major categories, but also in terms of the total number of "right" (e.g. MR, DPR) and "left" (e.g., PL, SPL) errors which have been made.

Scoring Principles and Samples

The underlying scoring principles for each design, followed by samples of correct and incorrect reproductions (with the specific errors listed under each faulty design), are presented on pages 12-41.

Since the scoring is based on explicitly stated criteria, there is usually no question as to whether a reproduction is correct or not. Occasional difficulties that arise in evaluating such aspects as size distortion, or the location of a peripheral figure, can often be resolved by making accurate measurements.

2 OF/DE 2

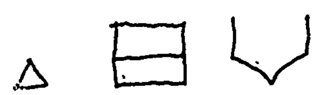
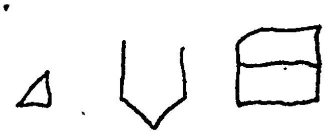


parallel to the edges of the paper (i.e., any rotation in the orientation of the major figures is ignored). In establishing the limits for the major figures, that figure which makes scoring more liberal is taken as the criterion. Thus, if a subject draws the two major figures in different sizes, or on different levels, the peripheral figure might be displaced with respect to one but not the other. In such a case, a displacement error would not be scored.

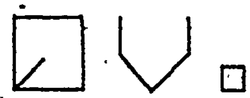
FORM D

DESIGN V

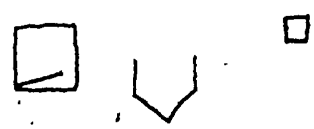
The small triangle must rest on a side, and be drawn so that at least a part of it lies in the area defined by the midline and lower limit of the major figures.

CORRECT	INCORRECT
	 Peripheral figure inverted (180 PI.)
	 Reversal of relative positions of two major figures (Rev.).
	 Incorrect reproduction of internal detail of right major figure (IMR).

FORM D

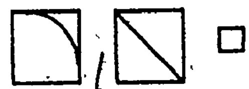
DESIGN VII 

The diagonal line in the square must not extend more than two-thirds of the distance to the opposite corner. The small square must rest on a side, and be drawn so that at least a part of it lies in the area defined by the midline and lower limit of the major figures.

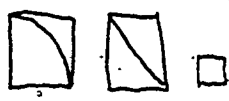
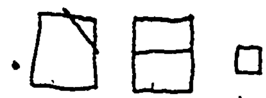
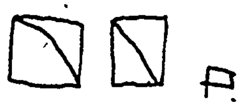
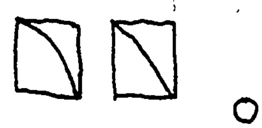
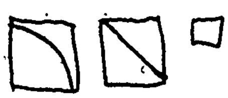
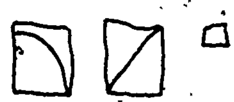
CORRECT	INCORRECT
	 Perseverative reproduction of peripheral figure from Design VI (PerPR).
	 Right major figure incorrect; peripheral figure too low (SMR:DPR).
	 Rotation of horizontal axis through major figures; peripheral figure too high (VerM: UPR).

FORM D

DESIGN VIII



The diagonal line in the left square must be curved, and that in the right square must be straight. Both lines must follow the direction indicated in the model and end at, or very near to, the corners of the squares. The small square must rest on a side, and be drawn so that at least a part of it lies in the areas defined by the upper and lower limits of the major figures.

CORRECT	INCORRECT
	 Incorrect reproduction of internal details of both major figures (IML:IMR)
	 Peripheral figure incorrect and too low (SPR:DPR)
	 Right major figure rotated (90MR.(Mirl).

APPENDIX III. McCarthy Scale
Scoring System
from McCarthy (1972).

SCORE: The scoring system for the Draw-A-Design test involves the use of specific criteria for each item.

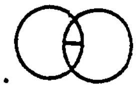
The imitative drawings, items, 1, 2 and 3, each have only one set of ceiteria, and are scored either 1 point or zero. Items 4-9 each have two sets of ceiteria -'minimum' and 'additional'; the minimum criteria are always presented first. Any drawing which meets all of the minimum criteria for its model design should be given an initial credit of 1 point. If less than all of the minimum criteria are met, the score is zero and there is no need to grade the drawing according to the additional criteria which follow. Any drawing which receives 1 point should next be graded according to the additional criteria, to determine whether additional credit has been earned. The total score for an item will depend on the number of additional criteria met. Items 4 and 5 each have a maximum score of 2 points; items 6-9 each have a maximim score of 3 points.

For items 4-9, to determine whether a drawing deserves an initial credit of 1 point, the scoring should be reasonably lenient, but scoring for additional credit should be quite strict.

For any items where the child has made a second drawing, score only the better of the two.

Rules regarding orientation of the figure are supplied where relevant.

Sample drawings accompany the scoring rules and are, in some instances, referred to by a boldface letter, to help clarify the rules. The beginning letters of the alphabet (A, B, etc.) have, in each case been assigned to the samples of the highest score for a given item. However, there has been no attempt to present the samples within one score in a graded sequence. The sample drawings are an integral part of the scoring system and should be utilized when scoring each item. (Most of the sample drawings have been reduced from their original size for printing in this manual).

MINIMUM CRITERIA: 6. 

* There are 2 intersecting circular or oval shapes. They may be poorly drawn but must be more curved than angular. (P barely passes this criterion but V fails.) One shape may be much larger than the other [O].

* The area of overlap created by the intersection is no larger than the remaining portion of either of the shapes. (J barely passes this criterion but X fails.)

* At the area of overlap, there are no embellishments such as small circles. (W fails this criterion.) There is no penalty if the short horizontal line is missing [K] or is drawn vertically [N]. Nor is there a penalty if an extra line is added [M].

If all of the above criteria are met, the drawing receives an initial credit of 1 point. If only two (or less) of the above criteria are met, the score is zero.

ADDITIONAL CRITERIA:

* The 2 intersecting shapes are well drawn and are more nearly circular than oval. (H barely passes this criterion, while E and G both fail.)

* The 2 intersecting shapes are of approximately equal size. (G barely passes this criterion but X fails.)

* The area of overlap is markedly smaller than the remaining portion of either of the shapes. (Although H passes the second Minimum Criterion, it fails this Additional Criterion.)

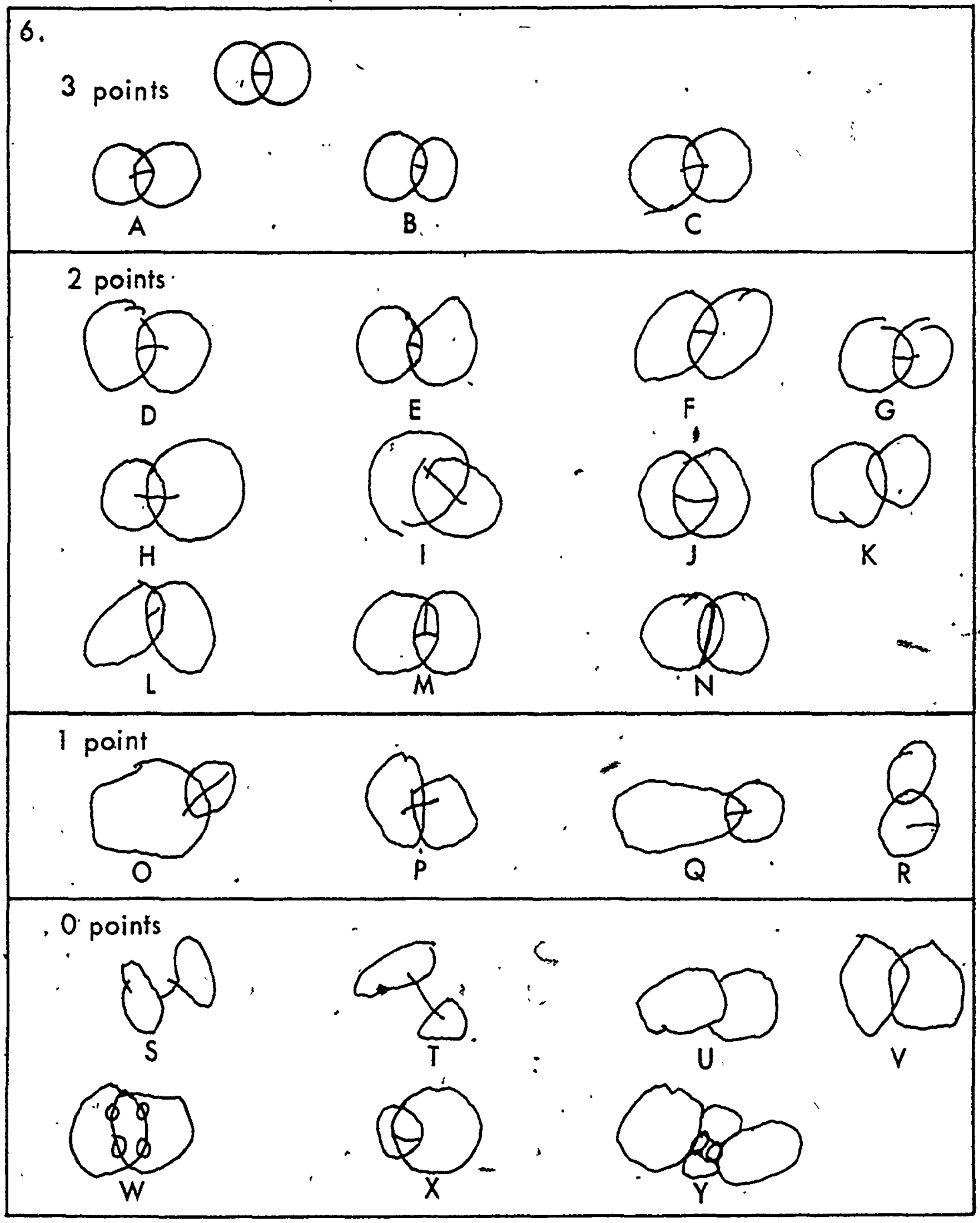
* A short horizontal line approximately bisects the area of overlap, is largely contained within it, and no other lines are drawn in that area. Furthermore, this horizontal line - if extended across the entire figure - would divide each of the circles into approximately equal halves. (F,G, and L all fail this latter requirements.)

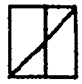
If all four of the Additional Criteria are met, the drawing receives 2 additional points - making a score of 3 points.

If two of three of the Additional Criteria are met, the drawing receives 1 additional point - making a score of 2 points.

If only one (or none) of the Additional Criteria are met, give no additional credit; the score remains 1 point.

Orientation - there is no penalty for rotation.



MINIMUM CRITERIA: 7. 

* The outline of the figure has 4 sides, all fairly straight but not necessarily of equal length. (O barely passes this criterion.)

* The outline of the figure is closed. (Gap of no more than 1/8 inch is permitted; an overrun of no more than 1/4 inch is also permitted.)

* The figure contains 2 intersecting lines. There is no penalty if these inner lines fail to touch the outline of the figure [M] or if they extend slightly beyond it [S].

If all of the above criteria are met, the drawing receives an initial credit of 1 point. If only two (or less) of the above criteria are met, the score is zero.

ADDITIONAL CRITERIA:

* The 4 sides of the figure outline are approximately equal. (No side is more than 1 1/3 times longer than another; A barely passes but K fails.) Furthermore, the 4 angles are each approximately 90°. (G and I both fail this latter requirement.)

* The 2 intersecting lines inside the figure are fairly straight. (P barely passes this criterion but O fails.)

* One of the 2 lines inside the figure connects the upper right and lower left corners of the figure. (E fails because it is a mirror image of the model; Q fails because the diagonal is too far away from the lower left corner.)

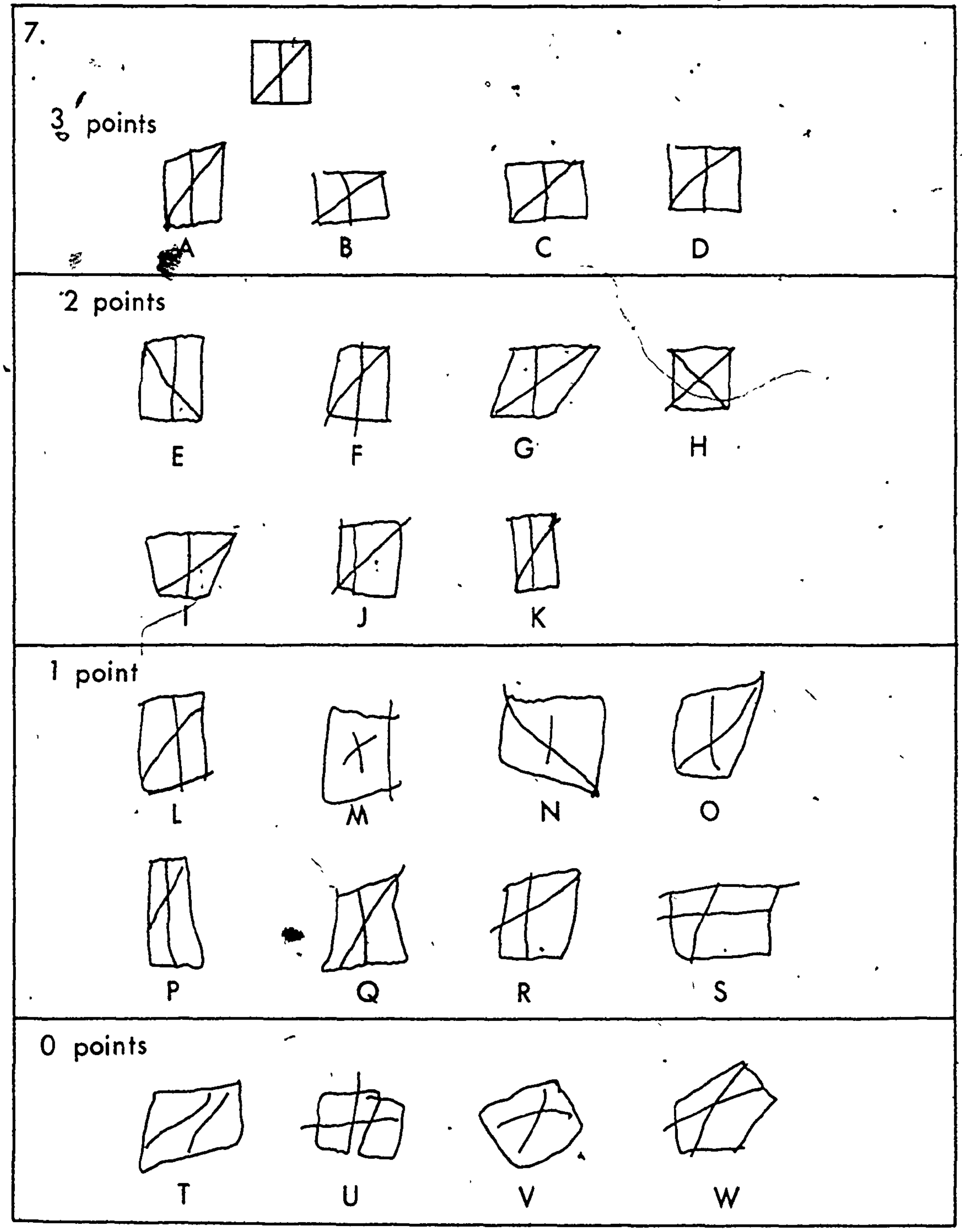
* One of the 2 lines inside the figure connects the approximate midpoints of the 2 horizontal sides of the figure. (P barely passes this criterion but J fails.)

If all four of the Additional Criteria are met, the drawing receives 2 additional points - making a score of 3 points.

If three of the Additional Criteria are met, the drawing receives 1 additional point - making a score of 2 points.

If only two (or less) of the Additional Criteria are met, give no additional credit; the score remains 1 point.

Orientation - No penalty for rotation, except that a mirror image of the model fails the third Additional Criterion.



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FIN

APPENDIX III. McCarthy Scale
Scoring System
from McCarthy (1972).